DSM ENVIRONMENTAL SERVICES INC.

February 29, 1996

Mr. Andrew Bellina, P.E.
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Region II, Hazardous Waste Facility Branch
290 Broadway, 22nd Floor
New York, NY 10007-1866

Re: Commonwealth Oil Refining Company, Inc. (CORCO)
Phase II - Subsurface Product Delineation Report
EPA SW ID# PRD-091017228

Dear Mr. Bellina:

DSM Environmental Services, Inc. (DSM) on behalf of Commonwealth Oil Refining Company, Inc. (CORCO) is pleased to submit the attached Phase II - Subsurface Product Delineation Report (3 copies enclosed).

Should you have any questions regarding this correspondence or require additional information, please contact our office at (713) 870-8676.

Regards,
DSM Environmental Services, Inc.

Joe H. Rafferty
President

enclosures

cc: PREQB - Israel Torres (2 copies enclosed)
CORCO - H.E. Gene Sebastian
Roberto Gratacos
Dale Byars (1 copy enclosed)
Edert Ortiz (1 copy enclosed)

DSM File No. - 1035-01\8.1 (G:\CORCO\Subsurf\1035-01\8.0\lt030196.doc)

1830 S. Kirkwood Suite 201 A. Houston, Texas 77077 Tel.: 713/870-8676

PHASE II - SUBSURFACE PRODUCT DELINEATION REPORT

COMMONWEALTH OIL REFINING COMPANY, INC. (CORCO)
Petrochemical Complex
Peñuelas, Puerto Rico 00624

DSM PROJECT NUMBER 1035-01

February 1996

Prepared By:
DSM Environmental Services, Inc.
1830 S. Kirkwood, Suite 201A
Houston, Texas 77077

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1.0 INTRODUCTION

DSM Environmental Services, Inc. (DSM), on behalf of Commonwealth Oil Refining Company, Inc. (CORCO, EPA ID# PRD-09107228) has prepared this "Phase II - Subsurface Product Delineation Report" in accordance with Section 5.1 of the EPA approved Phase II - Subsurface Product Delineation and Formation Evaluation Work Plan (Phase II Work Plan). Implementation of the Phase II Work Plan is a four step effort to gather data that will allow for the development of an efficient and effective product recovery plan for the site. The four areas of implementation, as detailed in Section 5 of the Phase II Work Plan, include Step #1 - Subsurface Product Delineation (completed by copy of this report); Step #2 - Subsurface product Pump Testing; Step #3 - Product Recovery Simulation; and Step #4 - Preliminary Design of a Product Recovery System. The reporting deliverables for the subsequent implementation steps will include the following:

- Phase II, Step #2 - Subsurface Product Pump Test Report,
- Phase II, Step #3 - Subsurface Product Recovery Simulation Report,
- Phase II, Step #4 - Subsurface Product Recovery System Preliminary Design Report.

1.1 Background

Construction of the CORCO, Peñuelas facility began in 1953. Initially, CORCO operated as an independent petroleum refinery and petrochemical manufacturer in the Commonwealth of Puerto Rico. The refinery operation was discontinued in 1982. The CORCO, Peñuelas facility currently operates as a terminal for the storage and distribution of petroleum products. The operation includes marine loading docks, a tank farm and a tank truck loading facility.

Petroleum product releases over time are common to petroleum refining, storage and transfer operations. Petroleum product was first identified in the subsurface at the CORCO facility's proposed location for the Modular Incineration System (MIS) during implementation of the 1989 Roy F. Weston (Weston) Environmental Impact Study investigation. Subsequently, a subsurface oil investigation work plan was included by EPA as a requirement of the June, 1990 CORCO/USEPA Settlement Agreement.

The August 30, 1990 Weston *Phase 1 Subsurface Oil Investigation Work Plan* (Phase I Work Plan) was submitted to the USEPA as required by the Settlement Agreement cited above. The January 24, 1994 EPA letter approved the Phase I Work Plan for implementation. The Phase I Work Plan was subsequently implemented by DSM in 1994 and the findings or results of this investigation were included in the November, 1994 DSM *Phase I Subsurface Oil Investigation Report*. The findings included the identification of five LNAPL product areas. These findings were based on the apparent oil thickness measurements from the 32 installed Phase I wells and the six previously installed MIS Area wells.

The January 24, 1994 EPA letter also required submission of a product recovery work plan and quarterly monitoring reports for the MIS Area. In response to this request, a *Product Recovery Work Plan - MIS Area* (DSM, April 15, 1994) was submitted to EPA and subsequently approved as per the May 9, 1994 EPA correspondence to CORCO. The June 17, 1994 DSM *Final Design Report* was approved by CORCO and led to the installation and operation of the MIS Area product recovery system. The start-up date for the MIS Area product recovery system was November 8, 1994. Quarterly monitoring reports for the MIS area have been submitted to EPA since the 2nd quarter of 1994. Through January 9, 1996 approximately 42,855 gallons of product have been recovered from the MIS Area.

1.2 Purpose

Further investigation with regard to product delineation and formation evaluation was considered prudent for the development of a effective an efficient product recovery program. The first step, Step #1 of the approved Phase II Work Plan, hereinafter "Phase II - Step #1", consists of gathering additional field data to determine groundwater flow gradient and to further define the nature and physical characteristics, the areal extent, and the actual thickness of the five LNAPL product areas identified in Phase I.

In addition, some data collected under Phase II - Step #1 will also be used for implementation of Step numbers 2 through 4 of the Phase II Work Plan.

1.3 Scope

Step #1 of the Phase II Work Plan outlined the following tasks for completion:

1) Installation of seven (7) additional delineation wells and five (5) pump test wells to include a GPS survey of newly installed and existing wells,
2) Core sampling laboratory analysis,
3) Geophysical logging and interpretation, and
4) Product physical characterization.

In addition to these planned activities, in-situ fluid flow measurements were also to be collected.

This report describes all field activities performed during the implementation of Phase II - Step #1 to include drilling, installation and completion of wells; well logging results and interpretation; physical analysis of product and core samples; and liquid level and fluid flow measurements. As a result of this investigation, this report will present:

- Product Delineation - a revised interpretation of the geometry of free-phase product in the subsurface, including a revised product delineation map,
- Subsurface Fluid Flow - a revised interpretation of the flow of water and oil in the subsurface at the site, including a revised groundwater gradient map and fluid flow data, and
- Formation Characteristics - a revised interpretation of the lithologic characteristics that control subsurface migration, accumulation of product, and groundwater fluid flow. The formation characterization data includes boring logs and geologic and hydrogeologic cross-sections.

2.0 SITE AREA DESCRIPTION

The CORCO, Peñuelas facility is located on the south-central coast of the island of Puerto Rico, approximately 55 miles (88 km) southwest of the capital city of San Juan. Ponce, the second largest city on the island, is 7.7 miles (12.4 km) east of the CORCO site. The CORCO property occupies a total area of approximately 500 acres (see **Figure 1,** Site Location Map).

The land adjacent to the terminal to the east, south, and west is used for industrial purposes. Undeveloped land is located to the north of Puerto Rico Route 2, which runs along the northern boundary of the terminal facility. Gulf Chemical Corporation (GCC) is located to the east, Puerto Rico Electrical Power Authority (PREPA) and Shell Company are located to the west, and South Pearl Chemical and Union Carbide are located to the south of the CORCO facility. The surrounding area, including the industrial neighbors listed above, is shown on **Figure 2**.

Site topography, climate, meteorological, vegetation, geological and hydrogeolgical data presented below are taken from the United States Geological Survey (USGS) Miscellaneous Investigation Series Map 1 - 1042 (Krushensky and Monroe, 1978), from the USGS report "Water Resources of the Tallaboa Valley, Puerto Rico" (Grossman et. al., 1972), USGS Report "Planning Report for the Caribbean Islands Regional Aquifer-System Analysis Project" (Gomez et. al., 1987) and from the U.S. Department of Agriculture Soil Conservation Service "Soils of the Sur Soil Conservation District and their Interpretations for Various Uses" (Gierbolini, 1973).

2.1 Topography

The CORCO facility is located in an area that has a topographical relief of approximately 330 feet. Approximately one-quarter of the site is situated in the low-lying Tallaboa Valley, where elevations ranges from 0 to 26 feet above sea level and three quarters of the property is situated on the southeastern edge of the upland ridge which divides the Guayanilla and Tallaboa River Valleys. The topography for the facility and surrounding area is shown on the site area topographic map which is included as **Figure 3**.

2.2 Climate, Meteorological, and Vegetation Data

The climate for the Tallaboa area of Puerto Rico where the facility is located is tropical. The temperature ranges from 55 degrees to 100 degrees F, with a mean temperature of approximately 79 degrees F. The facility lies in the semiarid foothills region and the dry southern coastal lowlands region. The Tallaboa valley receives an annual rainfall of 35 to 50 inches, however, the area remains considerably dry since evapotranspiration rates are nearly twice as great as rainfall rates due to temperature and wind conditions. Winds are commonly from the east at 10 to 15 miles per hour. Squalls are of short duration and infrequent. Native growth on the hills in the Tallaboa valley consist of cacti and other xerophytes, and irrigation is essential for practical farming in this area.

2.3 Geology

The CORCO Peñuelas facility area is located within the Tallaboa-Guayanilla-Yauco-Guanica sub-area of the south coast province of Puerto Rico. This area is characterized by Quaternary (Holocene) Alluvium. associated with stream valleys deposits, and weathered limestone that overlay the Miocene age Ponce Limestone formation in the southern portion of the site and outcropping Ponce Limestone which forms upland hills and ridges on the northern portion of the site. A general geologic map of the facility area is shown as **Figure 4** and a generalized hydrogeologic cross-section is shown as **Figure 5**. Note that the generalized geologic map and cross section do not differentiate between alluvium and weathered limestone.

The Ponce Limestone is described on the USGS 1978 Geologic Map as very pale orange to grayish orange generally crystalline calcarenite (cemented calcareous sand), containing abundant internal fossil molds (especially mollusk and solitary coral) echinoid and oyster shells, and foraminifera tests. The thickness of the Ponce limestone is reported to be over 600 feet to the north of the site and possibly approaching 2500 feet in the site area. The Ponce Limestone commonly strikes east-west with dips south at about 10 degrees. Individual dips range from 10 to 30 degrees to the south with dips rarely greater than 20 degrees. However, the 1978 USGS map reference indicates a dip measurement of 28 degrees to the southeast and a strike of north 33 degrees east along the northern CORCO property boundary.

The Constancia soils or weathered limestone have been mapped adjacent to the southern portion of the facility area by the U.S. Department of Agriculture. The Constanica soils are described as somewhat poorly drained and calcareuos throughout. They are noted to occur on the river flood plain of the semi-arid area and have formed from the weathering of limestone. The thickness of the weathered zone was indicated to be in excess of 5 feet in the U.S. Department of Agriculture report. A boring log included in the 1972 USGS report (p. 87) shows predominantly a clay to a depth of 64 feet below ground surface (bgs) for a coastal area well before entering a limestone (Grossman, et. al., 1972). The thickness of the weathered limestone/calcareous clay zone would presumably increase toward the coast.

The Quaternary Alluvium is reportedly composed of cobbles, pebbles, sand, clay, and sandy clay with the percentage of fine-grain material generally increasing toward the coast. The maximum thickness indicated by the USGS in the southern part of the Rio Tallaboa is estimated to be as much as 150 feet.

Quaternary (Holocene) Swamp Deposits and Beach Deposits have been mapped to the south of the site area. The swamp deposits consist largely of mangrove swamps, a mixture of sand, clay, and carbonaceous debris from mangrove trees. The beach deposits are sandy, locally containing cobbles, and commonly cross-bedded.

2.4 Hydrogeology

The subsurface Quaternary Alluvium and Ponce Limestone are reportedly unconfined water bearing units (USGS, 1972, p. 32). The coarse-grain alluvial deposits form the principal aquifer in the Tallaboa valley. Enhanced secondary porosity and permeability from dissolution of limestone by formation waters result in openings and cavities that can yield moderate supplies of water.

As indicated in the USGS 1972 report, increase in salt water concentration has adversely impacted groundwater wells located south of Highway 127 and to the east and west of the Rio Talloboa (Grossman et. al., 1972).

3.0 SITE DATA

Additional data was gathered during implementation of Step #1 by:

- installing seven (7) product delineation wells (DW-1 through DW-7) and five (5) pump test wells (PT-1 through PT-5);
- surveying existing and newly installed wells using global positioning system (GPS) technology supplemented with conventional surveying;
- measuring fluid levels in existing and newly installed wells;
- performing in-situ flow measurements in selected existing Phase I wells;
- collecting core samples for petrophysical measurements;
- collecting product samples for product characterization (viscosity and specific gravity analysis); and
- logging (induction and gamma) existing Phase I and newly installed Phase II wells.

The data gathered during the implementation of Phase II - Step #1 is discussed below. Literature, existing site data and field observations are included in the following discussions as appropriate.

3.1 Well Installation Data

Twelve (12) additional wells were installed during the implementation of Phase II - Step #1. The wells included seven (7) product delineation wells and five (5) pump test wells as illustrated on **Figure 6.** The wells were installed using a dual-tube, reverse air circulation (Drill Systems AP 1000) drill rig. Well Construction diagrams and copies of the field boring logs are included in **Appendix A.** Photoionization (PID) measurements were collected from representative composite samples over 5 foot intervals while drilling. The PID readings are shown on the boring logs included in **Appendix A**. Materials produced during drilling with elevated PID levels were containerized in DOT 17 H drums for characterization and disposal purposes.

During the installation of the Phase II - Step #1 wells, four major lithologic units were identified. These units are described as a massive friable limestone, an indurated limestone, a non-calcareous clay, and a weathered limestone or calcareous clay. The massive friable limestone, indurated limestone and non-calcareous clay units comprise the Ponce Limestone formation and are visible in outcrop at or near the site area. The calcareous clay appears to have formed from the in-situ weathering of the Ponce Limestone in low lying areas at the CORCO facility located south of Hwy. 127.

Cross-sections based on well log data were generated to define the geometry (area extent and thickness) of lithologic units encountered during drilling operations and the potential control that these lithologic units have on the migration and accumulation of product in the subsurface. Further discussion of the cross-sections which are based on well log and boring log data is included in Section 3.7. The four major lithologic units encountered during the drilling of the Phase II - Step #1 wells are discussed in greater detail below.

3.1.1 Massive Friable Limestone

This unit appears to have the hydraulic properties of both an aquifer (a formation that yields economic quantities of water to wells or springs) and an aquiclude (a poorly permeable formation that does not yield water freely). This hydrogeological description is also supported by flow velocity data derived from the in-situ fluid flow measurements discussed below in Section 3.5. In outcrops at the CORCO site, the Ponce Limestone is predominantly a massive friable limestone inter-layered with occasional non-calcareous clays and indurated or dense limestone layers. The massive friable limestone unit is porous and very fossiliferous with abundant corraline fauna. During drilling, the softer friable limestone is broken up into a calcareous silt and clay or rock flour which becomes a lime (calcareous) mud in the saturated zone. Cuttings over intervals of several feet were frequently composed entirely of powdered limestone when drilling through the Ponce Limestone.

The dissolution of the calcium carbonate by ground water has apparently led to enhanced secondary porosity of this unit which is evident by the formation of subsurface vugs or openings observed during drilling and in return core sections. A relatively large vug was encountered during the drilling of pump test well PT-2. This well required over a cubic yard of gravel for filter pack material during installation. Similarly, cavities were noted during the drilling of Phase I well PD-25 (located adjacent to well PT-2) which also required gravel packing to fill the subsurface cavity.

Fractures in this unit were observed in a few of the site outcropping sections. The continuity of individual fractures was not discernible and, therefore, the effect on fluid movement through fractures can not be predicted. However, prominent fractures were not apparent at most cut-wall site exposures.

3.1.2 Indurated Limestone

This unit can be referred to hydraulically as an aquiclude. This hydrogeological description is supported by the low permeabilities determined for this unit as a result of petrophysical core analysis (see Section 3.6 below). The indurated limestone layers produced the largest core sections. Selected core sections in the upper saturated zone were collected for petrophysical analysis. The indurated core sections had varying amounts of vugular porosity and ranged from very dense to medium dense with increasing porosity. The maximum length of a solid core section was 6 inches (3 inches in diameter) which is controlled by the bends in the return line as indicated by the drilling company. Several six inch (6") core sections were produced while drilling through indurated limestone layers.

3.1.3 Non-Calcareous Clay

This unit can also be referred to hydraulically as a aquitard (a geologic formation through which virtually no water moves). The non-calcareous clay was characteristically reddish brown and occasionally grayish green, was damp to moist and contained some shell fragments and calcareous concretions that were usually pebble size or finer. The clay matrix was not calcareous (i.e. did not effervesce with the addition of hydrochloric acid).

During drilling, a perched water zone was occasionally encountered above non-calcareous clay intervals. The perched water zones are believed to accumulate in structurally low saddles above the top of the clay bed. Undulations in bedding planes were observed in strike outcrop sections in the area. It is reasonable to assume that bedding plane undulations observed in outcrop are present in the subsurface and that perched water zones would accumulate above the structurally low clay bed undulations.

A perched water zone was encountered during the drilling of pump test well PT-1 at 114 to 120 feet below ground surface (bgs). As noted on the boring log for PT-1, a six foot clay interval was present beneath the perched water zone from 118 to 124 feet bgs. A clay interval was encountered at 34 feet bgs in delineation well DW-1 located approximately 345 feet to the north-

northwest, almost directly up-dip. If these clay units are correlative, the apparent dip of this clay interval would be equal to 16.4 degrees which is in-line with USGS measurements referenced in Section 2 above.

A perched water zone was noted during the drilling of well DW-3. The limestone encountered above a clay interval described at 89 to 94 feet bgs became very moist to wet and made some water at the 90 foot connection during the drilling of this well. A perched water zone was also noted during the drilling of well DW-4 at 175 feet bgs above a clay interval encountered at 182 to 184 feet bgs. At location DW-5 the limestone became wet at 90 feet bgs above a clay interval encountered at 90 to 94 feet bgs below the water table. A perched water zone was also encountered during the drilling of well PD-13 as noted in the Phase I report. Perched water zones noted during drilling operations were also identified using the induction logging tool. As noted above, well log and boring log data are further discussed in Section 3.7 below.

However, non-calcareous clay zones encountered during the drilling of Phase II wells were not always associated with perched water zones. At location DW-1 the limestone above the clay interval encountered at 34 feet bgs remained dry. At location PT-5 the limestone became damp at 20 feet bgs above a clay layer noted at 22 to 24 feet bgs. The occurrence of perched water zones appear to be both stratigraphically and structurally controlled (i.e. the perched zones occur in structural bedding plane lows or synclines above clay beds or inter-bedded clay and limestone intervals).

As noted in the Phase I field drilling notes, a product bearing zone was encountered during the drilling of well PD-12 at 35 to 36 feet bgs below a clay/limestone interface, which is approximately 11 to 12 feet below the water table surface. Note that product has not accumulated in well PD-12.

Therefore, the non-calcareous clay appears to also influence the migration and accumulation of oil in the subsurface.

Based on field observations and drilling data, the undulating, low-permeability, argillaceous clay beds should have a noticeable effect on the downward migration and accumulation of product to the subsurface at this site.

During the installation of the Phase II - Step #1 wells, bentonite seals were placed in the well casing bore-hole annulus in non-calcareous clay zones when possible to attempt to seal off perched water zones. The location of the bentonite seals for each well is indicated on the well construction diagrams included in **Appendix A.**

3.1.4 Weathered Limestone/Calcareous Clay

A weathered limestone unit was encountered while drilling the boring for pump test well PT-4. Weathering being define as "the group of processes, such as the chemical action of air and rainwater and of plants and bacteria and the mechanical action of changes of temperature, whereby rocks on the exposure to weather change in character, decay, and finally crumble into soil". Based on field observations during drilling, the Ponce Limestone has been altered in place into a calcareous clay south of Hwy. 127. The calcareous nature of the clay was confirmed in the field as the clay cuttings/cores effervesced with the application of dilute hydrochloric acid.

The weathered limestone/calcareous clay unit can be described hydraulically as an aquitard. The weathered limestone was brown, soft and moist at the surface and became gray to greenish gray, medium stiff to stiff, and very moist at 5 feet bgs. This unit contained calcareous clasts that range from silt to gravel size. The weathered limestone unit appears to correspond to the Constancia soils described by the U.S. Department of Agriculture and to the clay unit reported in borings for wells installed in the Tallaboa valley as reported by the USGS (Grossman et. al., 1972).

The weathered limestone/calcareous clay unit was encountered from surface to a total depth of 24 feet bgs during the drilling of the Phase II pump test well PT-4 located near the southern site margin. The total thickness of the weathered zone at PT-4 is unknown since the boring was terminated at a depth of 24 feet bgs in the calcareous clay. The Phase I boring logs for wells PD-1 through PD-8 located along the southern property margin also indicate that a clay was the predominant lithology in all borings. The weathered limestone was encountered during the drilling of delineation wells DW-6 from surface to 1 foot bgs. A clay was also encountered in the first 10 feet during the drilling of well DW-7, however, the clay was predominantly non-calcareous.

Based on the additional drilling data acquired during the implementation of Phase II - Step #1, the weathered limestone zone can be inferred to start just south of Highway 127 and coincides with the topographic slope break shown on the hydrogeologic cross-section included as **Figure 5**. Since the area to the south of these two wells is predominantly low lying marsh and grass covered fields, it is presumed that the thickness of the weathered zone increases to the south.

In addition to the four major lithologic units described above, a dark gray coarse sand was encountered from 26 to 29 feet below ground surface (bgs) while drilling DW-7 and fine gravel to coarse sand was encountered at the base of well PT-5 at 49 feet bgs. The petrophysical core analysis description of the unit encountered at 49 feet bgs in well PT-5 indicates a limestone conglomerate (see Section 3.6 below). A potentially correlative gravely silt was also noted at 26 feet bgs during the drilling of well PD-16 during Phase I implementation.

3.2 Well Surveying Data

During the implementation of Phase II - Step #1, a Global Positioning System (GPS) survey was performed to provide the most accurate lateral and vertical control of well casings and related measurements. The GPS survey data was converted to established Universal Trans Mercator (UTM) and latitude/longitude geodetic coordinate systems. The GPS survey was also performed to allow for the conversion of the existing plant grid survey to UTM and latitude longitude geodetic control systems. In areas where satellite signal interference from nearby obstructions inhibited the use of the GPS surveying, conventional surveying was used to supplement the GPS survey data using off-set locations established during the GPS survey. In addition, two GPS bench-marks were established on-site to facilitate future survey data acquisition needs.

The existing Phase I wells, the newly installed Phase II - Step #1 wells, and the MIS area monitoring wells (MW-01 and MW-02) were surveyed during implementation of Step #1. The top of casing data for the surveyed wells is included in the tabulated fluid level data discussed below. As noted above, a well location map, based on the new survey data, is presented as **Figure 6**.

3.3 Fluid Level Data

Following installation of the Phase I wells, fluid levels were measured in September, 1994 and August, 1995. Following the installation and surveying of Phase II - Step #1 wells, fluid levels were again measured in both the Phase I and Phase II wells in

November of 1995. The fluid level data for September, 1994, August, 1995 and November, 1995 is included on **Tables 1, 2** and **3**, respectfully. The top of casing elevation used to determine the static water level reflects the Phase II - Step #1 survey data.

3.3.1 Product Thickness Data

The apparent product thickness, measured in Phase I and Phase II - Step #1 site wells in September, 1994, August, 1995 and November, 1995, is shown on **Tables 1, 2,** and **3** respectfully. Review of the tabulated fluid level data indicates that the top of screen was set below the fluid level in several site wells. The top of screen values were measured during implementation of Phase II - Step #1 by using a bailer to tag the top of the internally ribbed wrapped PVC screen used during Phase I well installation. Based on a review of the data, it appears that in several wells, the screen was set too low to allow product, if present, to enter the well. Therefore, the product isopach map figure included in the *Phase I Subsurface Investigation Report* may not accurately portray the occurrence of product at the site. Where field notes boring log data for the Phase I wells indicated product and the well screens for these wells were set apparently to low to allow product to enter the well, the Phase I boring log data and the additional Phase II - Step #1 delineation well data were relied on as stronger evidence for the presence of product. Pertinent field note boring log data for the Phase I investigation is included on **Tables 10A** and **10B** under comments (see Section 3.7 on Well Log Data below).

The apparent measured product thickness data collected in September, 1994, August, 1995 and November, 1995 was compared to evaluate data variability. Apparent product thickness data is shown on **Table 4**. Based on the data comparison, it appears that the apparent product thickness in the wells installed in the Ponce Limestone have remained fairly constant while the apparent product thickness for the well completed in the weathered limestone/calcareuos clay unit (PD-4) has gradually increased. As noted below under product sampling data, the viscosity of the product material in PD-4 is markedly greater than the viscosity's measured for product material in the unweathered limestone and the density is slightly greater than (API gravity slightly less than) the density measured for product material in the Ponce Limestone. The consistency of product thickness measurements in the wells installed in the Ponce Limestone may indicate that the apparent product thickness in the wells have attained buoyant equilibrium. The consistency in these product thickness measurements may also reflect the relatively minor static water level fluctuations noted below in the following section on static water level data, since water table fluctuations have been shown to have a considerable effect on apparent product thickness measured in monitoring wells (Stotz et. al., 1990).

During the drilling of the well bore for pump test well PT-4, a moist clay was described from surface to total depth as very moist. A minor amount of product (approximately one inch thick) accumulated in the boring during drilling at the 10 feet bgs drill pipe connection. Subsequent to the well installation, water and product accumulated in the well to approximately 4 feet bgs. The apparent product thickness measured in the well casing approximately 2 weeks following the well installation was 1.71 feet thick while the apparent product thickness in the adjacent Phase I well (PD-4) was 19.21 feet. Note that the product thickness in the well PD-4 has increased over time from 12.06 ft in September, 1994 (measured 4 months after installation), to 18.23 ft in August, 1995, and to 19.21 ft in November, 1995. As noted below in Section 3.5, Product Characterization Data, the product identified in the weathered limestone has a slightly greater density and significantly higher viscosity. It appears that it takes longer for product encountered during the drilling of wells PD-4 and PT-4, completed in the weathered limestone/calcareous clay unit, to flow into the well and reach buoyant equilibrium due to this physical difference in the fluid and the formation.

3.3.2 Static Water Level Data

To determine the static water level for wells containing both product and water, a correction was required to account for the effect of the product thickness measured in a well. The product density was multiplied by the measured product thickness and the resulting value was added to the measured water level to determine the corrected or true static water level. Product density data collected during the Phase I investigation (see Table 6 of the Phase I report) and during implementation of Phase II - Step #1 (discussed below) were used in these calculations. Where product density data was not available, the product density data from an adjacent Phase I well was used for the corresponding Phase II - Step #1 pump test well. For the Phase II - Step #1 delineation wells, an interpolated density value was generated based on the product density data from nearby or surrounding Phase I wells. The corrected fluid levels for September, 1994, August, 1995 and November, 1995 are shown on **Tables 1, 2** and **3**.

The corrected (wells with product) and measured (wells without product) static water level data for the September, 1994, August, 1995 and November, 1995 were also compared to evaluate data variability as shown on **Table 5**. The range in values for the three measurement events were compared for each well and then the well ranges were statistically evaluated. It is assumed that water fluctuations across the site should be similar, at least in wells completed in similar lithologies (i.e. weathered limestone and unweathered limestone).

The average water level fluctuation, the standard deviation and the upper 99% confidence limit based on the average fluctuation range were calculated as shown on **Table 5**. Based on these calculations, several wells have water level fluctuations that exceed the 99% upper confidence limit. It would appear that even though the majority of water fluctuations are relatively small (32 out of 36 wells fluctuated less than 2 feet and 24 out of 34 wells fluctuated less than 1 foot), the water level fluctuations across the site are not consistent. The inconsistency in the water level fluctuation may indicate certain wells are being locally influenced, possibly by seepage from overlying perched water zones.

3.3.3 Groundwater Gradient Data

Three groundwater gradient maps were generated based on Phase I and Phase II - Step #1 fluid level measurements using Phase II - Step #1 survey data. The groundwater gradient map generated for the September, 1994 Phase I data was revised and is included as **Figure 7.** The groundwater gradient maps for the August, 1995 and for the November, 1995 Phase II - Step #1 data were generated and are included as **Figures 8** and **Figure 9**, respectfully. Anomalous values, which are indicated on **Tables 1, 2** and **3**, were omitted as control points for contouring purposes.

Anomalous values for the September, 1994 data include the groundwater levels measured in wells PD-13, PD-19, PD-20 and PD-31. As noted in the Phase I report, PD-13 was completed in a perched water zone. Wells PD-19 and PD-31 appear to be abnormally elevated, possibly due to the influence of an overlying perched zone. The fluid levels (oil and water) in PD-20 appear to have been misread for the September, 1994 measurement based on a comparison with the two sets of readings for this well collected in August and

November of 1995. The values for PD-13, PD-19 and PD 31 were also omitted for the reason described above (abnormally elevated) from the August, 1995 and November, 1995 gradient maps. In addition, the reading from PT-1, was omitted as an abnormal data point from the November, 1995 gradient map. The anomalous high groundwater level measured in PT-1 is attributed to the perched water zone encountered at 114 to 118 feet bgs (see boring log form for PT-1 in **Appendix A** and discussion in Section 3.1.3 above). It is anticipated that the head of water measured in PT-1 will dissipate into the formation and thereby allow representative water level measurements and product accumulation ·n this well and allow for pump testing during implementation of Step #2 of Phase II.

The three groundwater gradient maps (**Figures 7, 8** and **9**) are similar and show mounding of the water table in two separate areas. One area is in the weathered limestone with a water level high shown at well PD-7. The second mounding area occurs just north of the transition from the unweathered and weathered limestone units from east to west across the site. These two areas are discussed below.

The water level at PD-7 is approximately 6 to 7 feet above mean sea level or 3.5 to 4.5 feet bgs. During the implementation of the Phase II - Step #1 Work Plan, a storm-water ditch was observed along the south side of Insular Road #337, which forks off of and runs just south of Highway 127 adjacent to the southern margin of the site (see **Figure 2**). The ditch is approximately 6 feet deep and is located approximately 50 feet south of PD-7. The ditch was observed to be dry during implementation of Phase II - Step #1 even though it is apparently 2.5 to 3.5 feet below the water level measured in PD-7. The absence of water in the road-side ditch coupled with the description of the calcareous clay included on the boring log for well PT-4 and by the U. S. Department of Agriculture for the Constancia soils would support an interpretation that the weathered limestone/calcareous clay would act as a confining or partially confining layer and the groundwater mounding observed in this unit may reflect partially confined to confined conditions in the area in close proximity to PD-7.

The groundwater mounding noted in the area trending parallel to the unweathered/weathered limestone contact (which runs parallel to and just south of Hwy. 127 at the site) may be indicative of a decrease in transmissivity from the unweathered limestone to the weathered limestone. This explanation was also described and graphically displayed on a conceptual cross-section in the DSM July 13, 1995 correspondence to EPA. As noted above, the conceptual hydrogeologic site cross-section has been revised (see **Figure 17**) and is further discussed in Section 3.7 below. The mounding appears to result in a localized reversal of groundwater flow on the north side of the mounded area. This reversal is also supported by in-situ fluid flow data discussed below.

The weathered limestone or calcareous clay that is present along the southern margin of the CORCO facility south of Hwy. 127 pinches out to the west of CORCO based on field observations. West of the pinch-out, the Ponce Limestone dips directly into the Guayanilla Bay. To the west of the site and north of the bay a prominent ravine or drainage valley has formed and is shown on the site topo map, **Figure 3**. The ravine, which has formed in the Ponce Limestone, drains to the southwest to the Guayanilla Bay and into the Caribbean Sea. Based on the groundwater gradient maps (**Figures** 7, **8** and **9**) and in-situ fluid flow measurement data (see Section 3.4 below and **Figure 8**), groundwater appears to flow to the northwest and west in the direction of this ravine bordering the western portion of the site along the northern flank of the mounded area shown north of Hwy. 127. Upon entering the ravine area, the groundwater would presumably flow to the southwest following the drainage direction of the ravine toward the sea.

The absence of groundwater data south of the site precludes further interpretation of the groundwater gradient in that direction. Based on boring log data for PT-4 (see boring log form for PT-4 in **Appendix A**) and U.S. Department of Agriculture soil data, the calcareous clay present at the southern portion of the CORCO facility should significantly inhibit the migration of product based on the inherent lithologic and hydrogeologic properties of a clay (low permeability, high specific retention and low effective porosity or specific yield).

3.3.4 Tidal Influence Data

During the implementation of the Phase II - Step #1 Work Plan, tidal influence on water fluid levels were evaluated by collecting sets of water level measurements over a tidal change period. Water level measurements were collected in PD-3 on November 14, 1995 and in PD-1 on November 17, 1995. Tidal data was taken from the weather section (El Tiempo) of the El Nuevo Dia newspaper. The weather department of this newspaper indicated that an approximate one-half hour lag in time occurred for the tides listed in the newspaper for the San Juan Area as compared to the Ponce Area. Copies of the newspaper tidal data for the two days in which corresponding water level measurements were collected, are included in **Appendix B** and are summarized below.

Tidal Influence Data

Well Number	Date	Time 0-2400 hr	Depth to Water (ft)	Tide Time/Level
PD-3	11/14/95	1145	7.73	1325/1.7 ft
PD-3	11/14/95	1900	7.68	2015/0.7 ft
Fluctuation PD-3 vs. Tide			0.05 ft	1.0 ft
PD-1	11/17/95	0855	5.02	0940/0.7 ft
PD-1	11/17/95	1650	5.12	1540/1.5 ft
Fluctuation PD-1 vs. Tide			0.1 ft	0.8 ft

Review of the data in the table above appears to indicate that tidal changes have a negligible effect on water level measurements for wells completed in the weathered limestone/calcareous clay unit. Note that well PD-1 is located approximately 200 feet from Guayanilla Bay. Also note that the well completed in the Ponce Limestone nearest to the bay (PD-9) is approximately 2000 feet from Guayanilla Bay. Although the tidal data indicates that the effects of the tide are negligible and decrease with distance from the bay (PD-1 vs. PD-3), additional data in the Ponce Limestone unit will be collected during implementation of Step 2 of Phase II Work Plan, pump testing. During the pump tests, barometric, tidal, draw-down and recovery data will be recorded and evaluated.

3.4 *In-Situ Fluid Flow Data*

In-situ or downhole groundwater flow measurements were collected during the implementation of Phase II - Step #1. KVA Associates, Inc. (KVA) groundwater flow monitoring equipment (model 40L) was used to measure on-site flow velocity and direction following laboratory calibration with the existing 10 slot wrapped (CircumSlot^{TM}) PVC screen. The probe used to measure flow velocity and direction works on the principal of preferential heat attenuation due to naturally occurring flow within a well screen interval. Dr. William Kerfoot, co-founder of KVA and inventor of the downhole flow monitoring equipment provided on-site consultation during groundwater flow measurements. Procedures, calibration and completed field forms, reflecting in-situ fluid flow field measurements, are included in **Appendix C**. Fluid flow vectors and the corresponding depth below the fluid level at which the vector was measured are shown on the August, 1995 groundwater gradient map (**Figure 8**).

The groundwater flow velocity and direction were measured in product and water bearing zones of selected Phase I and MIS Area wells. The measured velocity and flow direction data is included on **Table 6**. **Table 6** also includes the measured depth with respect to top of casing, top of screen and fluid level, the fluid (oil or water) the probe was in when collecting data, precision calculations and comments regarding the resulting data.

When collecting groundwater or product fluid flow measurements, the probe was set inside a 5 foot screened section to avoid taking readings at connections where the pipe is solid. When collecting oil flow measurements, the probe was set as close to the top of screen as possible to ensure that readings were collected in the oil bearing zone.

To evaluate the precision, duplicate sets of readings were collected at several measurement locations. The following standard equation was used to evaluate precision.

$$RPD = |S-D| / (S+D)/2 \times 100$$

where,

RPD = Relative Percent Difference
S = First Sample Value
D = Second Sample Value

The duplicate values appear relatively close with only 4 out of 24 RPD values exceeding 50 percent. The accuracy of the in-situ flow velocity data will be further evaluated by comparing the in-situ flow velocity data with flow velocity data calculated based on pump test data collected during implementation of Step #2 of the Phase II Work Plan.

The velocity data from the in-situ fluid flow measurements, groundwater gradient data, and porosity data from reference standard text and core analysis data can be used to calculate formation hydraulic conductivity using the following equation.

$$K = (v^*n_e)/i$$

where,

K	= Hydraulic Conductivity,
v	= Velocity,
I	= Hydraulic Gradient, and
n_e	= effective porosity

Hydraulic conductivity estimates will be calculated to determine initial pump test flow rates that will be used during implementation of Step #2 of the Phase II Work Plan.

Although locally high flow velocity values were measured in some well screens in wells completed in the Ponce Limestone and these measurements correspond with drilling data (i.e. high velocities were measured at 141 ft bgs in well PD-25 at the same depth solution cavities were noted for this well and the adjacent pump test well, PT-2), it is probably safe to assume that the overall movement of fluid through this massive limestone is controlled by the lower permeable zones since there is no evidence that these higher permeable zones are interconnected throughout the site.

KVA Associates, Inc. noted that the site in-situ flow velocity values measured in the calcareous clay were close to the lower calibrated range of the instrument. It appears that in formations with low flow velocity (i.e. clay), the in-situ flow velocity data may be more reflective of the well bore/filter pack material than actual formation conditions.

To further evaluate flow velocity data for the non-calcareous clay, published literature values for hydraulic conductivity of clays were reviewed and used to calculated flow velocity. Hydraulic conductivity for clay is reported to range from 1×10^{-3} ft/day to 1×10^{-7} ft/day (EPA, 1985). Assuming a high end conductivity value of 1×10^{-3}, an effective porosity of 5% (Driscoll, 1986) and a hydraulic gradient of 0.01 ft/ft (estimated from the gradients shown on Figures 7, 8, and 9) the groundwater velocity in the clay would be on the order of 2×10^{-4} ft/day or 0.073 ft year. In other words, groundwater movement through the calcareous clay is negligible. Therefore, the accumulation of product in the area of PD-4 would be expected to be localized due to the low permeability and fluid velocity estimated for this clay unit and to the relatively high product viscosity measured for the product sample that was collected for analysis from well PD-4. Product characterization data is discussed in the following section.

3.5 Product Characterization Data

Product samples were collected from Phase I wells that are proposed to be used as pump test off-set or observation wells for the Phase II pump test wells. The product samples were analyzed for density and viscosity. The product physical characterization analytical data is included in **Appendix D**. The product density data compares closely with the density data included in the Phase I report (see Table 6 of the Phase I Report). Product density data for Phase I and Phase II - Step #1 are shown on **Table 7**.

As noted above, the product density was multiplied by the measured product thickness and the resulting value was added to the measured water level to determine the corrected static water level. Viscosity data was collected for evaluation and modeling of pump test results.

The viscosity and density of the product sample collected from well PD-4 completed in the weathered limestone/calcareous clay unit (well PD-4) are greater than the viscosity and density of the product samples collected from wells completed in the Ponce Limestone. Based on historical site data, kerosene or heating fuel product blends were predominantly stored in tanks located south of Hwy. 127 while gasoline product fuel blends were predominantly stored in tanks located north of Hwy. 127. As noted in the previous section, the greater viscosity of the product and lower formation permeability of the weathered limestone/calcareous clay unit should have a significant impact on product migration through this unit as well as the product recovery strategy.

3.6 Core Analysis Data

Drilling with the dual-tube reverse air Drill Systems AP-1000 drilling rig allowed for continuous returns of formation cuttings and cores while drilling. As noted above in Section 3.1, cores were circulated with the return air while drilling through the indurated limestone. To a more limited extent, more indurated or less friable portions of the massive limestone unit produced smaller core pieces in comparison to the indurated limestone cores.

Cores were collected, when possible, while drilling through the oil and water bearing zones for the pump test wells borings. Core samples were collected for analysis from the borings for pump test wells PT-2, PT-3 and PT-5. Petrophysical analyses were performed on collected core samples. The petrophysical core data is summarized on **Table 8** and is included in **Appendix E**.

The core samples provide an estimate of porosity, permeability, fluid saturation and grain density for the indurated limestone unit. As discussed in Section 3.1, the indurated limestone beds which make the largest core pieces were only occasionally encountered during drilling. With the exception of fluid saturation (see discussion below), the parameter values measured for the core pieces are considered reliable, but not representative of the formation as a whole which is predominantly a massive friable limestone. It was unknown at the on-set of Phase II - Step #1 how indurated the overall formation was and to what extent recoverable core samples could be collected for analysis using the dual-tube reverse air drilling technique.

3.6.1 Core Porosity Data

The petrophysical analysis provided a measure of total interconnected porosity which should be greater than the effective porosity or moveable pore water (since it includes the volume of water held to the solid matrix) and less than or equal to the total porosity, which includes interconnected and non-interconnected pore water. The porosity values are in close agreement with published values for indurated or consolidated limestone (Driscoll, 1986).

The total porosity for the indurated limestone should be less than the total porosity for the more friable, massive limestone since porosity is a function of surface area and the more friable limestone is composed of numerous clay to gravel sized particles which provide greater surface area. The interconnected porosity for the indurated limestone should also be less than the interconnected porosity for the massive friable limestone due to the granular nature of the latter. As noted in section 3.1, rock flour material encountered during the drilling of the massive friable limestone in the Phase II - Step #1 wells is described as a lime mud in the zone of saturation (i.e. very porous with low permeability). Based on the fine-grained granular nature of the massive friable limestone, a total porosity of 40% is used as an estimate for water saturation calculations discussed in Section 3.7.4 below.

3.6.2 Core Permeability Data

The petrophysical analysis provided a measurement of core permeability for the indurated limestone unit. Permeability expressed in millidarcies (md) was calculated in terms of K-air and K-Klinkenberg (Kl) or non-reactive liquid permeability as explained in **Appendix E**. (Note: one millidarcy is equal to 0.00243 ft/day). Kl permeabilities ranged from 0.0014 ft/day (0.578 md) to 1.51 ft/day (621.6 md) for solid core samples. Conductivity or permeability values for the indurated limestone layers based on petrophysical core analysis are in the range of unjointed or non-fractured limestone (Driscoll, 1986). This data supports the earlier statements above, that fracture flow in the Ponce Limestone is probably not significant in the site area and for the hydraulic definition of the indurated limestone as an aquiclude to an aquitard

3.6.3 Core Fluid Saturation Data

Petrophysical analysis was used to provide an estimate of the relative fluid saturation with respect to oil and water. Since air circulation was used to return the cores to the surface, the percent fluid (oil plus water) saturation is notably less than 100 percent as indicated in the core sample results. Presumably, oil was volatilized from the core in greater proportion than water. Note that attempts to core/drill without air were unsuccessful.

The core sample collected from the boring for well PT-5 at 19 feet bgs (Sample 6 on Table 8) was collected well above the saturated zone and the core sample collected from 28 feet bgs (Sample 7 on Table 8) was collected from just above the saturated zone. The remainder of the core samples were collected from the saturated zone.

Core samples collected from the boring for well PT-2 at 141 feet bgs, from the boring for well PT-3 at 33 and 38 feet bgs and from the boring for well PT-5 at 29 and 31 feet bgs (Samples 1, 3, 4, 8 and 9 on **Table 8**, respectively) were collected from within the oil bearing zone based on boring log data. The core sample collected from pump test well PT-5 at 38 feet bgs (Sample 10 on **Table 8**) was collected close to the boundary of the base of the oil bearing saturated zone and top of the water bearing zone based on boring log and fluid elevation data. Core samples collected from the boring for well PT-2 at 160 feet bgs, from the boring for well PT-3 at 45 feet bgs and from the boring for well PT-5 at 49 feet bgs (Samples 2, 5 and 11 on **Table 8**) were collected from within the water saturated zone based on boring log and fluid elevation data.

The measured oil saturation in cores samples collected from the oil bearing zone (samples 1, 3, 4, 8 and 9) range from 0.0 to 6.4 percent. This indicates that with air pressure a significant percent of the in-place oil is removable from the oil bearing zone. Although product recovery by pumping should be significantly less efficient than with pressurized air, the data is encouraging to the extent that the oil can be liberated, however, the amount of residual oil after pumping can not be accurately predicted based on this data. Further evaluation of oil recovery efficiency will be evaluated with the continued implementation of the Phase II Work Plan.

The water saturation values for the core samples collected from the oil bearing zone (samples 1, 3, 4, 8 and 9) range from 57 to 78 percent. This indicates that the formation is predominantly water saturated in the oil bearing zone. Since the formation was water saturated prior to the migration and accumulation of product, then it is presumed that as the product entered the water saturated zone the product displaced interstitial and interconnected pore water. Since it is presumed that most of the oil saturation and some of the water saturation was lost as a result of this sample collection procedure, a reasonable estimate of the water saturation in the oil bearing zone is 75 to 80 percent. This estimate is supported by water saturation calculations base on induction log data discussed in the following section.

3.6.4 Core Grain Density Data

The petrophysical analysis also determined the grain density of the core samples. Core grain density values ranged from 2.70 to 2.72 grams per cubic centimeter (g/cc) with an average density of 2.71 g/cc. Standard reference density data for limestone is 2.71 g/cc.

3.7 Well Logging Data

Well logging was performed on existing and newly installed site wells. The logging suite included a natural gamma log (gamma log) and an induction log. These log suites are appropriate for logging in non-salt saturated drilling mud, oil, air filled or PVC cased bore-holes. The logging equipment was rented from Colog, Incorporated. Instrumentation was calibrated prior to rental and prior to use in the field.

The logging tools are electrically connected to a data logger which records data at the surface. The data logger is linked to a computer with software that enables the data to be formatted into tables or presented in graphical form. Graphical logs generated from the Phase II - Step #1 logging runs are included in **Appendix F**. Data collection, evaluation and interpretation of the induction and gamma logging data are discussed below.

3.7.1 Data Collection

In some instances, the PVC stick-up for existing Phase I wells was slightly off-vertical which prevented the insertion of the gamma log probe into the casing. The conductivity probe, which is slightly narrower than the gamma log, was inserted into all wells, however, some equipment damage was incurred as a result of the tight squeeze.

Slight deviations in the PVC screen alignment also inhibited the lowering of the induction resistivity or conductivity and gamma sondes or probes to the base of most of the deeper Phase I wells (PD-19 through PD-32). Note that the Phase I wells were installed without centralizers. Since, the inside diameter of the CircumSlot™ PVC wrapped screen is only slightly greater than the outside diameter of the sondes, any slight deviation or bend in the casing inhibited the insertion of the sondes.

To insure well alignment for the Phase II - Step #1 product delineation wells, stainless steel centralizers were used in ten (10) of the twelve (12) installed wells. Two (2) wells were installed without a centralizer, DW-1 (the first well installed) and DW-3. These wells were set with a tension line attached to the top of the casing and the filter pack and bentonite pellets were tremied through the annulus of the drill pipe. During installation of DW-1, the stainless steel tape used to collect downhole measurements became lodged below a sand bridge while setting the filter pack. As a result of trying to free the tape, the well casing became off-centered at depth and a bend in the casing occurred at approximately 160 feet bgs. To ensure that the logging equipment would not become bound or lodged and possibly damaged or not retrievable from the well, the well was not logged.

Installation procedures using a tension line and centralizers were experimented with on the next two, 2 inch ID delineation wells installed (DW-2 and DW-3). Note that the 4 inch ID pump test wells had to be installed using centralizers since the casing and screen could not be installed inside the 3 inch drill pipe annulus, which was the only option available with the rig used during this phase of the investigation. Installation procedures were deemed more effective with centralizers with regard to keeping the well centered and allowing proper placement of the filter pack and seal for the two inch delineation wells.

Each one (1) foot long stainless steel centralizer interfered with the induction log record for a distance of approximately 10 feet. The stainless steel centralizers used during installation rendered the induction log tool unusable for interpretation in the saturated zone since two to three centralizers were installed in this interval to keep the screen aligned and off the bore-wall during installation. As a result, the availability and performance of PVC centralizers will be investigated for future well installations.

3.7.2 Gamma Logging Data

Gamma log sondes record natural formation gamma radiation. Natural formation gamma radiation is indicative of non-calcareous clay which usually contains potassium (K), a part of which includes the unstable K^{40} isotope (Dresser Industries, Inc., 1974). Therefore, the gamma log can be used to map the occurrence of clay layers encountered during the drilling of Phase II - Step #1 delineation wells due to the presence of the K^{40} isotope.

The procedure used for identifying clay beds is to draw a vertical line on the gamma log that intersects the majority of gamma readings or traces. This value tends to be around 20 to 30 counts per second (CPS on the graphic log scale) and may be referred to as the zero percent clay baseline. Positive readings (deviations to the right of 20 or more CPS) or peaks are indicative of non-calcareous clay beds.

To correlate clay beds identified in one well with clay beds in an adjacent well along strike, the gamma log traces at an approximate equal elevation to a known datum (i.e. sea level) are compared. Note that individual clay beds are fairly homogenous with respect to clay mineral content and therefore produce similar responses when logged. Since the wells may not be perfectly aligned in a strike (zero degree dip) direction and the beds were observed in outcrop to have an undulating surface, the log traces are slid slightly in a vertical direction (up or down relative to each other) to match clay peaks. In some cases a clay bed can be inferred to be continuous across the site. In other instances, the clay bed appears to have more limited extent. Therefore, by correlating the log traces, the geometry of the clay beds can be evaluated.

When correlating gamma log traces along the strike direction, the induction conductivity trace, which is discussed further below, could be used to evaluate if clay peaks with similar responses at similar elevations occur at a structural high (anticline) or low (syncline) of the bedding plane surface. Conductivity peaks that occur adjacent to and above the clay peak are an indication of a perched water table. If a perched zone was identified in association with a clay peak from one log and not with a correlative clay peak in an adjacent log, the assumption was made that the well with the conductivity or perched zone occurred at a low or syncline in the clay bed. Vice-versa, if a conductivity peak was not present, it could be assumed that the structural position of the clay bed was at an anticline or high.

When correlating clay traces in the dip direction, the gamma traces were aligned from north to south and again hung on sea level datum. The distance between the wells and the dip of the beds were taken into considered. On dip sections most clay beds do not intersect the well immediately to the south due to the horizontal distance and the dip of the beds. A dip of 20 degrees was assumed based on the regional and local dip measurements reported by the USGS (See Section 2).

The gamma log response to bentonite seals set above the filter pack during well installations creates a peak that masks the true formation response. For correlation purposes the peak associated with the bentonite seal had to be ignored. For Phase I wells, a clay unit could be inferred to be present where the bentonite seal was set if a perched zone was identified adjacent to and slightly above the seal using the induction conductivity log. For Phase II - Step #1 pump test and delineation wells, the bentonite seal was placed at argillaceous clay intervals for most deep wells during installation to provide a seal against water seepage from the overlying perched water zones, if present. Therefore, where bentonite seals were placed at known clay layers for Phase II - Step #1 delineation wells, the clay unit is inferred and is correlated, if possible, with adjacent Phase I clay intervals based on their elevation.

Taking into consideration the aforementioned correlation procedures, two stratigraphic strike (NE-SW) cross-sections and four structural dip (NW-SE) cross-sections were constructed utilizing the well log data. The location of these cross sections are shown on **Figure 10** and the strike (A-A' and B-B') and dip sections (C-C' through F-F') are included as **Figures 11** through **16**.

The well log correlation data shown on the stratigraphic cross section figures (**Figures 11** and **12**) reflect predominantly limestone lithology with interlayered clay beds and some prominent clay layers. Some of the inter-layered clay beds and clay layers have greater lateral continuity than others. Associated with some of the clay beds, are positive responses in the conductivity curve. As noted above, the conductivity peaks detected in the vadose zone represent perched water zones based on the interpretation of the well log data in conjunction with drilling/boring log data. The perched water zone described in PD-13, rest on top of a clay unit encountered at 20 feet bgs (See **Figure 12** Cross-Section B-B' and the graphical log in **Appendix F**). Similarly, the perched zone described at approximately 80 to 90 feet bgs in well DW-3 exhibits an induction log peak.

Based on the evaluation of the boring log and well log data, the conceptual hydrogeological model for the site, described and graphically portrayed in the July 13, 1995 DSM letter to EPA, has been further refined. The revised conceptual hydrogeologic site cross-section is included as **Figure 17.**

3.7.3 Induction Logging Data

The induction log was run to determine the true oil-bearing thickness in the formation as opposed to the apparent oil thickness measured in the well casing/screen. This data is discussed below. Induction log and water conductivity data were also used to estimate the percent of water and oil saturation in the oil bearing zone. Saturation calculation data is discussed in Section 3.7.4.

Numerous authors have commented on the discrepancy between measured oil thickness in well borings and actual oil thickness in the formation (Testa,. and Paczkowski, 1989; Ross, et. al., 1989; Hughes, et. al., 1988; Chiang, et. al., 1990). These papers indicate that the apparent or measured thickness verse the actual or formation thickness is generally much greater by a factor of 2 or more times. However, there are instances where the measured product thickness has been noted to be less than the actual product thickness as a result of water level fluctuations (Stotz, et. al., 1990). In some instances, biofouling and skin effects at the bore-wall interface or preferential water flow into the bore-hole may also inhibit the migration of formation oil into the well screen.

Induction logging was selected as the initial tool to evaluate apparent verse actual product thickness at this site. The induction logging tool measures electrical conductivity using current generated by coils (Asquith,, 1982). The EMP-2493 induction probe used has coil spacing at 50 cm (20 inches) and a maximum radial depth of investigation of 28 cm (11 inches). The induced currents are recorded as conductivity by receiver coils. By focusing the current and eliminating unwanted signals, a deeper reading of conductivity is taken and more accurate values of true formation resistivity are determined. These readings are graphically displayed as the conductivity trace in the middle tract and resistivity in the far right tract of the logs included in **Appendix F**. Note that both these tracts are generated from the same response and that the relationship between the conductivity and resistivity reading when using standard measurement units (ohms-meters) is expressed as:

$$\text{Conductivity} = 1000/\text{Resistivity}$$

In order for the induction tool to be successful in delineating formation oil bearing zones from water bearing zones, the conductivity of the formation water needs to be much greater than the conductivity of the oil and the ratio of oil to water or the percent of oil present in the oil bearing zone has to be great enough to effect the induction reading. Since this site is located in close proximity to the coast, a sufficient contrast in water and oil conductivities was assumed to be present for delineation purposes. Other factors including the presence of clay layers occurring in the upper part of the saturated zone will tend to increase conductivity and depress resistivity and thereby masked the occurrence of product oil.

Review of the induction log traces, conductivity and resistivity, has led to the following observations or interpretations for wells completed in the Ponce Limestone (all wells except PD-1 through PD-8 and PT-4). With respect to conductivity, the conductivity of a perched water zone is greater than the conductivity of the water saturation zone which is greater than the conductivity of the unsaturated vadose zone (zone of aeration above the water table). Perched zones should have the highest conductivity since the formation water is not in constant circulation and evaporation would tend to increase the percent of dissolved solids which is directly proportional to the conductivity reading (Driscoll, 1986).

With respect to resistivity readings in the Ponce Limestone, the resistivity of the vadose zone with residual oil saturation is much greater than the resistivity of an oil/water saturated zone which is greater than the resistivity of the water saturated zone. Note that where PID readings were recorded during the Phase I investigation, the elevated readings measured in the vadose zone correspond to residual oil detected using induction logging identified in the vadose zone.

The procedure used to identify the oil bearing zone is to examine the top of the saturated zone and determine if the conductivity curve is suppressed (associated with a corresponding peak in the resistivity curve) at the top of the zone of saturation. A comparison of the estimated product thickness (EPT) based on induction log interpretation can then be made with the measured apparent oil thickness (APT) in the well casing by using a dual interface probe. This comparison is shown on **Table 9A** for the weathered limestone unit and **Table 9B** for the Ponce Limestone. **Tables 9A** and **9B** includes the total depth of well, total depth of induction log, depth to product if applicable, depth to water, depth to top of screen, apparent product thickness (APT) based on well measurements, the estimated product thickness (EPT) based on log interpretation, and comments that reflect interpretation considerations supplemented with boring log data.

The use of induction logging to identify product bearing zones in the weathered limestone was not as effective as in the Ponce Limestone. The reason for the lack of induction logging success in the weathered limestone appears to be due to the natural formation characteristics. As the formation becomes more saturated with depth, the conductivity increases as shown on the induction log response (see log traces for wells PD-1 through PD-7 in **Appendix F**). Even though a product bearing zone is present in wells PD-4 and in the adjacent pump test well PT-4, the product bearing zone does not noticeably depress the conductivity trace between the surface and a depth of 12 to 13 feet bgs in the log trace for PD-4. Note that the product bearing zone was observed at a depth of 10 to 11 feet bgs during the drilling of these two adjacent wells. At a depth of approximately 12 to 13 feet bgs, the maximum conductivity response occurs for wells PD-1 through PD-7 and is attributed to the zone of maximum water saturation. One exception to this observation was noted for the induction log response for well PD-5. Well PD-5 exhibits a depression of the induction conductivity log within the zone of maximum water saturation. This depression could possibly be due to the presence of hydrocarbon product, however, no product was noted while drilling this well.

Well PD-8 was also completed in the weathered limestone unit. The induction log response for well PD-8 is relatively flat which corresponds to the low conductivity measured in field samples collected from this well (see Table 11), to the low calculated salinity and to the high calculated formation water resistivity (R_w) for this well. As noted above, the flat response due to low conductivity of formation water inhibits the effectiveness of the induction logging tool for effectively delineating product bearing zones.

The relationship between estimated oil thickness and measured oil thickness appears to be inconsistent based on log interpretation data verse drilling log data for the weathered limestone unit. Since a product bearing interval was only encountered in well PD-4, it appears that product in the weathered limestone calcareous clay unit is confined to the area of PD-4. As noted above, the low calculated groundwater flow velocity for the weathered limestone/calcareous clay unit (0.073 ft/yr) coupled with the high viscosity measurement for the product sample collected from well PD-4 should minimize migration of product in this unit in this area of the site.

Review of **Table 9B** indicates that for a limited number of wells, induction logging and physical conditions were favorable for making a comparison between actual and estimated product thickness in the Ponce Limestone.

The relationship of apparent measured thickness (APT) verse the estimated product thickness (EPT) using induction logs for wells completed in the Ponce Limestone is shown below.

Well Number	Average APT (ft)	EPT (ft)	Ratio of EPT/APT
PD-9	9.80	5.8	0.59
PD-10	10.27	4.4	0.43
PD-18	3.41	2.0	0.59
PD-27	8.49	6.0	0.71
DW-3	9.64	4.0	0.41
Average ratio of EPT/APT			0.55

The table above shows a fairly close relationship between the apparent measured product thickness and the estimated product thickness based on induction logging interpretation. Adjusted product thickness values were calculated based on the apparent product thickness multiplied by the EPT/APT ratio for wells that have accumulated product. The adjusted calculated product thickness values are shown on **Table 10**. Note that the logging data for well PD-14 was not used to assess the relationship between APT & EPT, since it appears that the perched water zone identified using induction logging is effecting the accumulation of product in this well and possibly the height of the water table (see Table 5).

3.7.4 Oil Water Saturation Data

Induction logging can be used to estimate the relative saturation of oil with respect to water in the product bearing zone. The percent water saturation S_w is calculated using the Archie Equation (Asquith,, 1982).

$$S_w = \left(\frac{F \times R_w}{R_t} \right)^{1/n}$$

where,

S_w = Water saturation,
F = Formation resistivity factor,
R_w = Resistivity of the formation water,
R_t = Resistivity of the formation, and
n = Saturation exponent; and

$$F = a/\phi^m$$

where,

a = Tortuosity factor,
ϕ = Porosity, and
m = cementation exponent

Several authors/companies have developed log interpretation values or range of values for the tortuosity factor, cementation exponent and saturation exponent that work in various geographic areas for unconsolidated and consolidated limestone and sand/sandstone.

The cementation exponents used for unconsolidated materials is less than those used for consolidated material, however none have been derived specifically for a weathered calcareous clay. Carothers developed a cementation exponents for carbonates that ranged from 1.7 for calcareous sands to 2.15 for indurated limestone and a cementation exponent for shaley sands of 1.33 (Asquith,, 1982). Exxon recommends values of 1.3 for unconsolidated formations (loose sands and oololitic sands) and 1.4 to 1.5 for very slightly cemented formations (Exxon, 1980). A cementation exponent value of 1.4 was used for the Ponce Limestone and a value of 1.3 was used for the weathered limestone.

The tortuosity factor commonly used for limestone is 1.0, however, a value 0.85 was developed for consolidated carbonates and 1.45 for calcareous sands. A tortuosity factor value of 1.0 was used herein for the Ponce Limestone. The tortuosity factor commonly used for unconsolidated sands is 0.62 and was used for the weathered limestone/calcareous clay unit.

Saturation exponents range from 1.4 to 2.1 for sandstone and 1.8 to 2.5 for limestone with 1.8 regarded as the best average saturation exponent (Exxon, 1980). A value of 1.8 was used for the Ponce Limestone and the weathered limestone unit.

Porosity values should vary in the Ponce Limestone depending on the specific unit, friable limestone or indurated limestone. Petrophysical core data porosity for the indurated limestone ranged from 12 to 27 percent. As noted above, the more friable limestone unit with a fair percentage of limestone silt and clay could have porosity in excess of 40 percent. Porosity for clays range from 40 to 55 percent (Driscoll, 1989). A porosity value of 40 percent was used for the Ponce Limestone and 50 percent for the weathered limestone calcareous clay.

The formation water resistivity R_w is based on the salt content of the formation water, primarily with respect to sodium chloride (NaCl). Formation water samples were collected from five selected wells for conductivity, chlorides, and four major cations, sodium, potassium, magnesium and calcium analyses. The samples were collected from selected wells across the site. The analytical results are included in **Appendix F**. The analysis was performed to determine if a direct relationship between conductivity and salt content could be established, since the salinity of the formation water is directly related to the formation water resistivity and to determine if the formation waters were conductive enough to show a response to oil saturation if present. The relationship between salinity and formation water resistivity R_w is shown on the chart titled Resistivity Graph for NaCl Solutions included in **Appendix F**. Field and laboratory salinity and conductivity measurements are included on **Table 11.** The relationship between salinity and conductivity of the formation water samples collected for laboratory analyses is summarized below.

Well Number	Conductivity mS/m	NaCl ppm	Ratio of NaCl/Conductivity
PD-4	5,655	27,111	4.79
PD-5	1,898	10.081	5.31
PD-12	546	3,427	6.28
PD-14	377	1,731	4.59
MW-1	190	865	4.54
Average ratio of NaCl to Conductivity			5.32

Based on the data tabulated above, a direct relationship between conductivity and salinity was established. The formation water conductivity for most wells was high enough to provide a positive conductivity response when logging in the saturated zone and a depressed conductivity response was sometimes observed when logging through product bearing zones. Further, field measurements of conductivity could be multiplied by the NaCl to Conductivity factor (5.32) to obtain a reasonable approximation of the formation water salinity. The calculated formation water salinity could then be used to determine the formation water resistivity (R_w) from the chart included in **Appendix F** which graphically illustrates the relationship between water salinity and resistivity with respect to temperature. Note that formation water temperature is approximately 75 degrees F based on field measurement data.

The formation resistivity value R_t was taken directly from the numerical logged value. Each well log data file induction log value was imported into a spreadsheet as a text delimited file. With the other variables of the Archie equation defined above, the percent of oil in the oil bearing zone could be determined based on the water saturation calculation.

Archie equation calculation spreadsheets are included in **Appendix F** for well PD-5 completed in the weathered limestone and for wells PD-9, PD-10, PD-18, PD-27 and DW-3 (wells used to estimate the actual product thickness based on induction logging data) completed in the Ponce Limestone. The Archie equation is solved on the spreadsheet in the water saturation column. The input variables are also shown on the spreadsheets and interpretative notes are listed adjacent to the water saturation calculated values, where applicable.

The Archie equation calculation results for the wells completed in the Ponce Limestone, indicate a minimum water saturation of 80 percent in the product bearing zone (see spreadsheet calculation for well PD-9 in **Appendix F**). Therefore, the maximum oil saturation for this zone is equal to 20 percent, since the total percent saturation of 100 percent minus the calculated water saturation is equal to the estimated oil saturation. Higher water saturation or lower oil saturation were calculated for the other wells noted above.

As noted above in Section 3.7.3, the induction logging tool reads over a 20 inch vertical zone. Therefore, water saturated zones, either above or below the product bearing zone should effect the induction logging tool and this effect should increase as the thickness of the product bearing zone decreases. The product bearing zones identified with use of the induction logging tool at the site are relatively thin (i.e. 1 foot to less than 6 feet). In addition, several product bearing zones were located beneath overlying perched water zones. The logging tool will therefore detect the water saturated zones located adjacent to (in a vertical direction) the product bearing zone while the probe is being used to collect readings from within the product bearing zone. Therefore, although the logging tool can be used to detect the top and bottom of the product bearing zone, the water saturation calculation will tend to underestimate the percentage of product or overestimate the water saturation value in relatively thin product bearing layers. This effect becomes more pronounced as the thickness of the product bearing zone decreases.

Based on a review of the core saturation data, the induction log traces and the Archie equation spreadsheet calculations, the percent oil saturation in the product bearing zone is estimated at 25 percent.

The percent of water saturation should also vary within the product bearing zone. The percent of water saturation should be at a minimum where product has accumulated in the pre-existing capillary fringe zone and should be at a maximum at the base of the product bearing zone (generally referred to as the oil water contact). Note that water-free product (the water-in-oil sensor cuts the pump off at water percentages greater than 0.1%) has been recovered in the MIS Area since the subsurface pneumatic pumps have been set just above the pre-existing water table in the pre-existing capillary fringe zone.

3.7.5 Product Occurrence, Thickness and Volume

Product that has migrated in the subsurface to the water table should occur above and below the pre-existing water table. The pre-existing capillary fringe zone, which is located directly above the water table, should have had a water saturation of 100 percent at the water table contact. The percent of water saturation in the capillary fringe will decreased in a vertically upward direction. The rate of decrease in saturation in the capillary fringe is controlled by grain size, and therefore, the finer the grain size the higher the water will rise. The height of the capillary fringe is therefore anticipated to be equivalent to that of other fine grained materials due to the friable fine grained nature of the Ponce Limestone formation. Approximate heights of the capillary fringe due to capillary forces which include cohesion (attraction of water molecules to each other) and adhesion (attraction of water molecules to solid material) is estimated to be 1 to 3 feet for fine grain sand to silt size material (EPA, 1985).

As the current product migrated into and through the capillary fringe zone, a product layer formed above and below the water table. Product that accumulated in the pre-existing capillary fringe (i.e. above the water table) displaced some interstitial water just above the water table surface and filled-in interstitial pores where the capillary fringe was not 100 percent saturated. Product that accumulated below the water table displaced pre-existing interstitial groundwater due to the added mass of the product. The greater the product density for a light non-aqueous phase liquid the greater the amount of displacement of water with product below the pre-existing water table. As noted above, the apparent thickness measured in the well is generally greater than the thickness of product measured in the formation. The greater value of the apparent measured product thickness in comparison to the actual formation product thickness is due to the absence of formation capillary forces in the well which resist product displacement forces (Sullivan et. al., 1988).

Recovery of the oil will in effect reverse the process and as product is recovered water will displace the removed product from the periphery (edge water drive) and from beneath (bottom water drive) the product bearing layer (Craft and Hawkins, 1959). These processes and their relationship to optimizing product recovery will be further evaluated during Steps #2 through #4 of the Phase II Work Plan.

A revise product isopach map, included as **Figure 18**, was generated based on the adjusted calculated product thickness values shown on **Table 10**. Where the screen was set too low and inhibited product from entering the well, a product thickness contouring value was generated based solely on log interpretation data, if available (note some wells could not be logged deep enough to interpret an oil water contact from the log trace). Where the screen was set high enough to allow product to enter the well and no product was encountered during drilling based on visual observation, then the well was considered to be beyond the areal extent of the product layer. Wells considered beyond the extent of the product layer include wells PD-22 and DW-5. Wells DW-2, DW-6 and DW-7 are considered to be at the approximate edge of the product layer based on measured product thickness and boring log data.

To estimate the amount of subsurface product occurring in the Ponce Limestone and the weathered limestone at the site, the area and thickness of product layer taken from the site isopach map (Figure 18) was multiplied by the formation porosity estimated at 40 percent (see discussion in Section 3.6.1) and then by the calculated oil saturation estimated at 25 percent (see discussion in Section 3.7.4 above). Based on the additional data collected during implementation of the Step #1 of the Phase II Work Plan, the volume of in-place product is estimated to be 599,734 barrels. The in-place oil volume calculation for this report is summarized on **Table 12**.

The current in-place product volume estimate of 599,734 barrels is less than the in-place product volume estimate of 1,379,351 barrels that was calculated in the Phase I report (see Section III, 1.1 of the Phase I report). The reduction in the estimated volume of in-place product is due primarily to the volume of water contained in the product bearing zone that was previously inferred to be saturated one-hundred percent (100%) with oil. The reduction in product thickness estimate (the estimated thickness is approximately one-half the apparent measured thickness), based on induction logging data discussed above, is more than offset by the increase in product area (10.3 million square feet are estimated in this report as compared to the 2.6 million square feet estimated in the Phase I report). The increase in area is based on the delineation well and induction log data which indicate that the product layer in the Ponce Limestone consists of one product layer instead of the four discrete or isolated product layers as indicated on Figure 13 of the Phase I report.

Due to the relatively low formation permeability of the weathered limestone/calcareous clay unit and the relatively high viscosity of the product occurring in this unit, the extent of product in the calcareous clay should be limited to the immediate vicinity of adjacent wells PD-4 and PT-4 as shown on **Figure 18**.

4.0 OBSERVATIONS/CONCLUSIONS

Base on the results of the Phase II - Step #1 investigations the following observations and conclusions are submitted.

1. The Ponce Limestone is primarily a massive friable formation. The formation contains indurated or hardened layers of limestone and non-calcareous clay layers. The non-calcareous clay layers act as permeability barriers, support perched water zones and effect the migration and accumulation of product in the subsurface.
2. Groundwater mounding occurs at the site in two areas. The first area is located just north of the contact of the non-weathered and weathered Ponce Limestone formation and is influenced by a reduction in flow capacity or transmissivity from the non-weathered to weathered formation. The second area is in the weathered limestone/calcareous clay unit and appears to be the result of partially confining to confining conditions. Groundwater flow in the Ponce Limestone is predominantly to the west and northwest behind the mounded area toward a prominent topographical ravine located to the west of the site. The weathered limestone/calcareous clay unit, which develops just south of Hwy. 127 and thickness to the south, presents a transmissive flow barrier to product and groundwater regionally flowing south from the unweathered Ponce Limestone. Fluid flow in the calcareous clay is negligible (i.e. 0.073 ft/yr).
3. Water levels in some wells completed in the Ponce Limestone appear to be effected from overlying perched water zones. Tidal influence on water level fluctuations appears to be negligible.
4. Product thickness in wells completed in the Ponce Limestone appear to reach a buoyant equilibrium relatively quickly provided the screen is set in the oil bearing zone. Product thickness in wells completed in the weathered limestone/calcareous clay unit take longer to reach buoyant equilibrium. The additional time it takes for the product to reach bouyant equilibrium in these wells (PD-4 and PT-4) is attributed to the higher viscosity of the product and the low permeability of the clay unit in this area.

5. The ability of the Ponce Limestone to transmit flow is primarily through intergranular pore spaces. Fracture flow does not appear to be a significant flow factor. Flow rates in the massive friable limestone unit are in the range of fine to coarse granular material based on in-situ fluid flow measurements, whereas flow rates for the indurated limestone layers are in the range of unjointed or non-fractured limestone (several orders of magnitude lower) based on petrophysical core measurements.
6. The non-calcareuos clay layers in the Ponce Limestone are fairly continuous and support perched water zones in the vadose zone based on induction conductivity and gamma log data supported by the drilling/boring data.
7. Residual oil saturation in the vadose zone is apparent, based on induction resistivity logging and corresponds with subsurface boring data (organic vapor monitoring).
8. The water saturation in the oil bearing zone is approximately 75 percent based on Archie equation calculations using induction resistivity log data and field and laboratory water conductivity and salinity data. Water saturation in the oil bearing zone is also supported by petrophysical core fluid (oil and water) saturation data.
9. In comparison with the Phase I report results, the area of product appears to be larger and the thickness is less. Individual or isolated pools of product are not supported by the additional delineation wells or the logging data. The overall volume of fluid (oil and water) in the product bearing zone is greater than the volume of product estimated in the Phase I report, however, the overall volume of product in the product bearing zone is less than the Phase I product volume estimate since approximately 75 percent of the fluid in the product bearing zone is believed to be water. The percent of water saturation in the product bearing zone is based on the induction logging water saturation calculations and the core fluid porosity data.
10. The occurrence of product in the weathered limestone/calcareous clay unit is localized to the area in the vicinity of PD-4 and PT-4 based on the low permeability of the clay unit and the relatively high product viscosity.

5.0 RECOMMENDATIONS

As a result of the implementation of Step #1, five pump test wells were installed (PT-1 through PT-5). The well installation procedures for wells PT-2 through PT-5 went smoothly and pump test design and implementation can begin for these wells. As noted in Section 3.1 a perched zone was encountered at approximately 120 feet bgs during the installation of PT-1 (located adjacent to MW-5). Although the bentonite seal was set in the casing bore-hole annulus at the clay layer underlying and supporting the perched water zone, the water level in PT-1 was anomalously high (see Table 3) and is attributed to seepage from the perched water zone. It is hoped that at the time of field pump testing, the water level will have adjusted back to static water conditions and oil will have accumulated in the well casing to allow for product pump testing from well PT-1.

Due to the scheduling and weather delays encountered during implementation of Step 1, the Phase II Work Plan implementation schedule included as Figure 6 of the Phase II Work Plan report has been revised to reflect the incurred delays. The revised implementation schedule is included as **Figure 19**.

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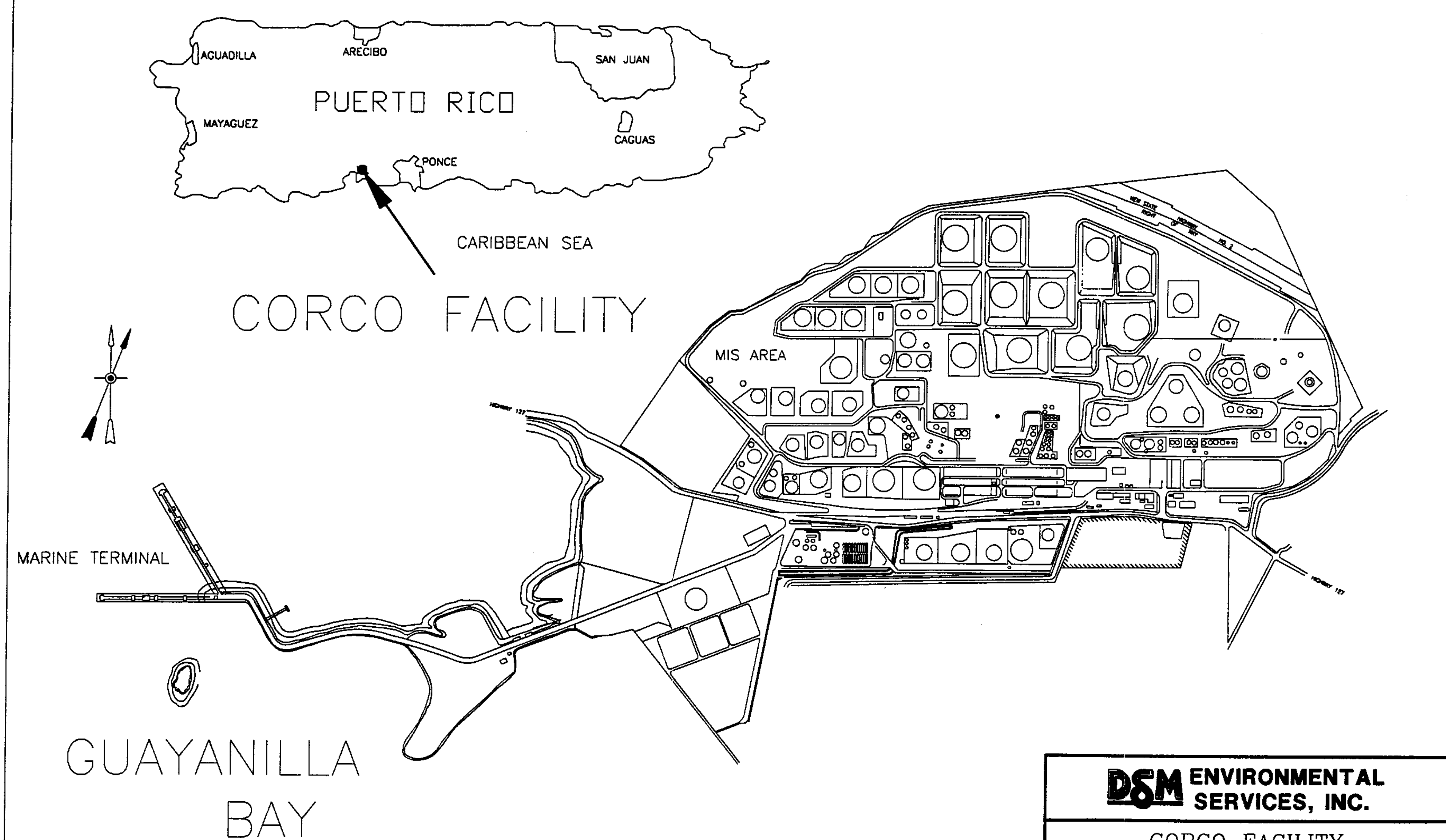
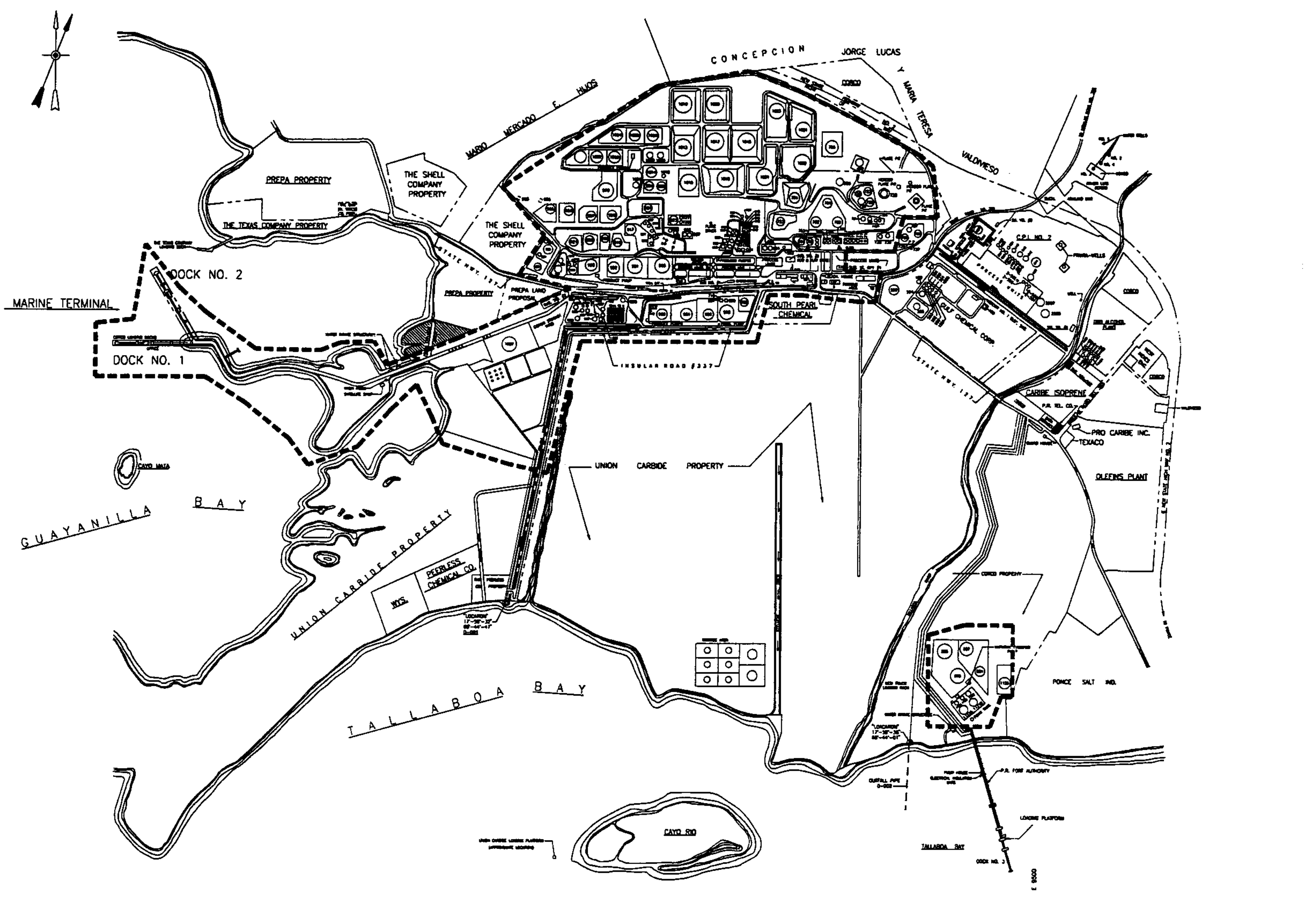


DSM ENVIRONMENTAL SERVICES, INC.

CORCO FACILITY
SITE LOCAL MAP
PENUELAS, PUERTO RICO

PROJECT: 1035	DRAWN BY: RJG	CHK'D BY: PD	REV: 1
DATE: 1-29-96	SCALE: NTS	FIGURE: 1	DB NUMBER:

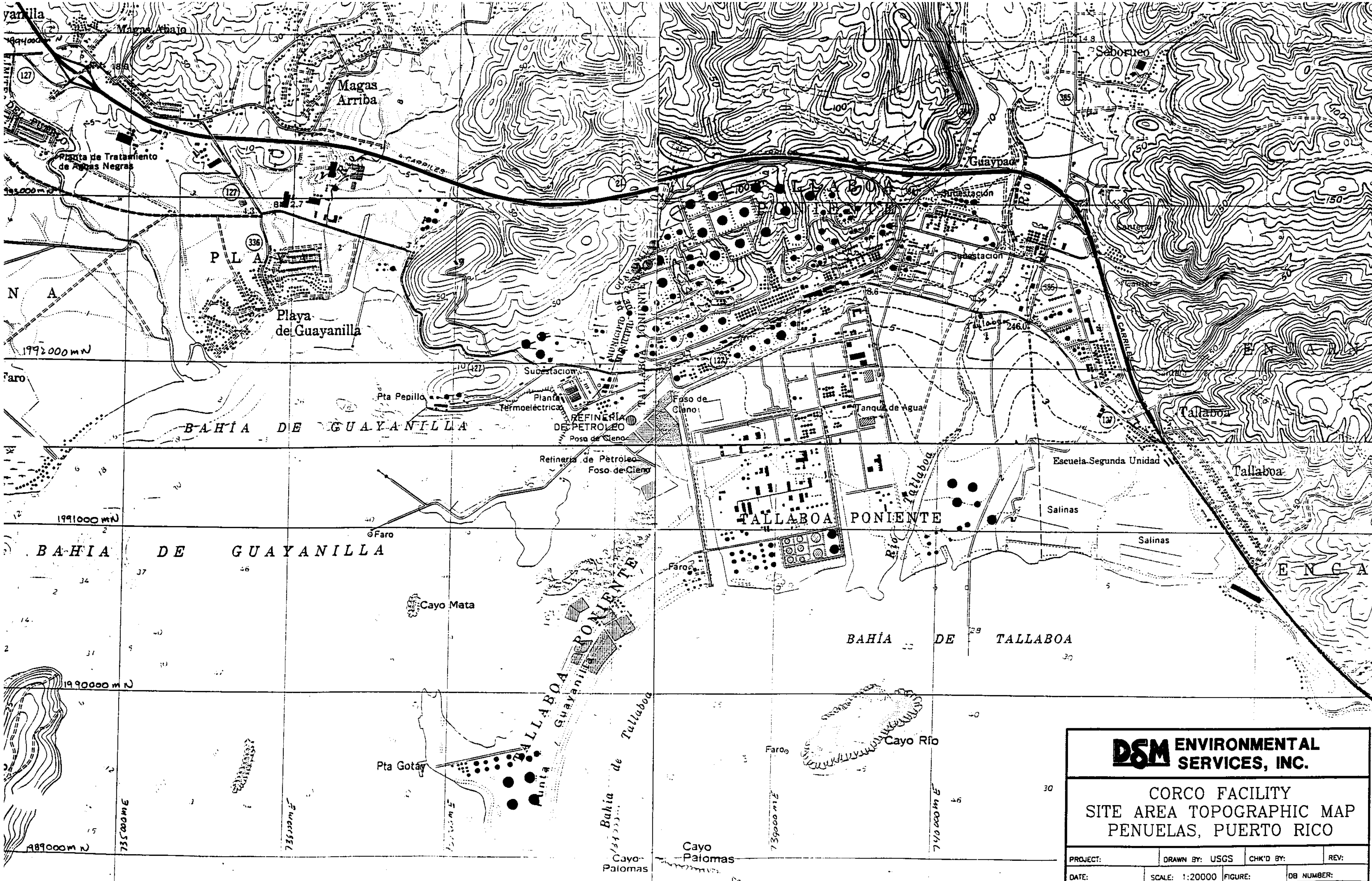


CORCO FACILITY OPERATIONS OUTLINE

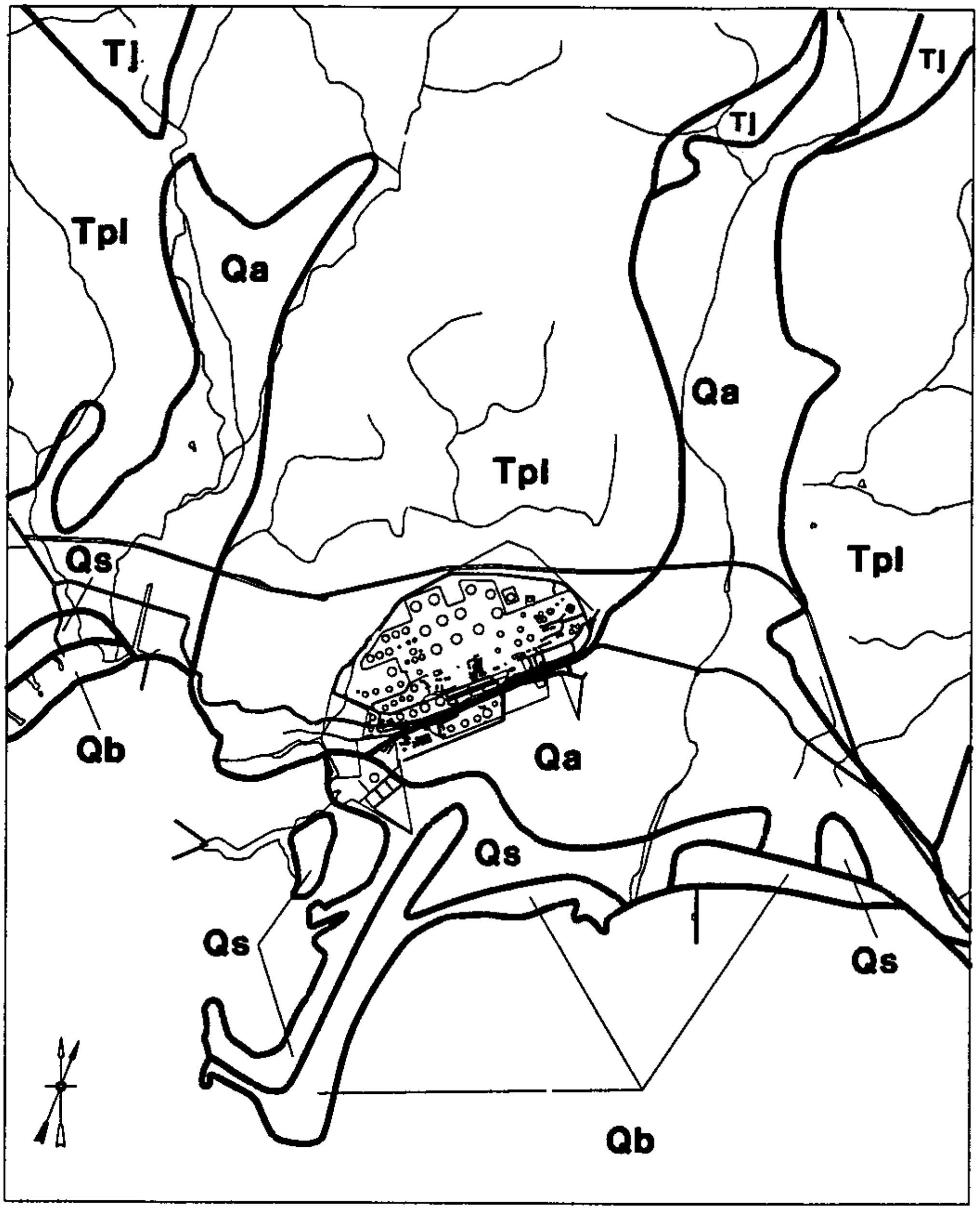
DSM ENVIRONMENTAL SERVICES, INC.

CORCO FACILITY
SITE VICINITY MAP
PENUELAS, PUERTO RICO

PROJECT: 1035	DRAWN BY: RJG	CHK'D BY: PD	REV: 1
DATE: 1-28-98	SCALE: 1"=1600'	FIGURE: 2	DB NUMBER:



DSM ENVIRONMENTAL SERVICES, INC.				
CORCO FACILITY SITE AREA TOPOGRAPHIC MAP PENUELAS, PUERTO RICO				
PROJECT:	DRAWN BY: USGS	CHK'D BY:		REV:
DATE:	SCALE: 1:20000	FIGURE:		DB NUMBER:



LEGEND

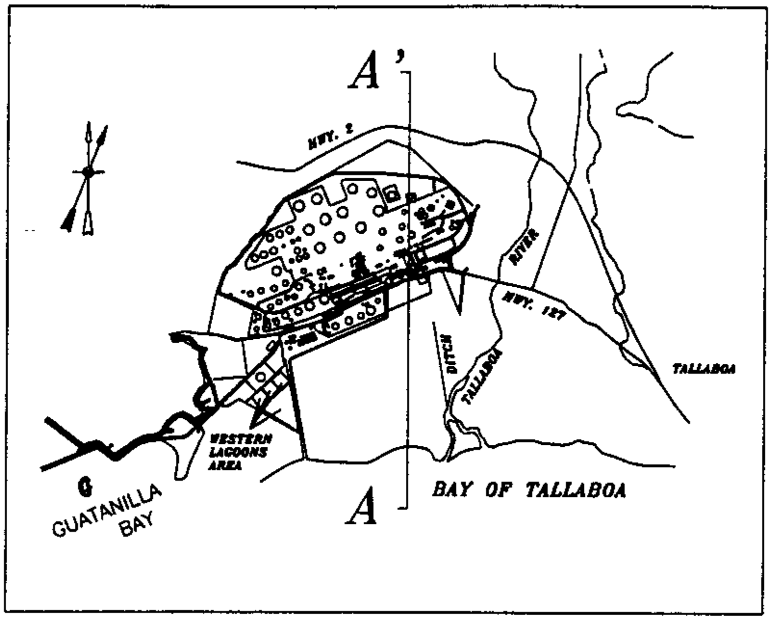
Qa	Alluvial Deposits Pleistocene and/or recent
Qb	Beach & Dune Deposits Pleistocene and/or recent
Qs	Swamp & Marsh Deposits Pleistocene and/or recent
Tpl	Ponce Limestone Tertiary Oligocene & Miocene
Tj	Juana Diaz Formation

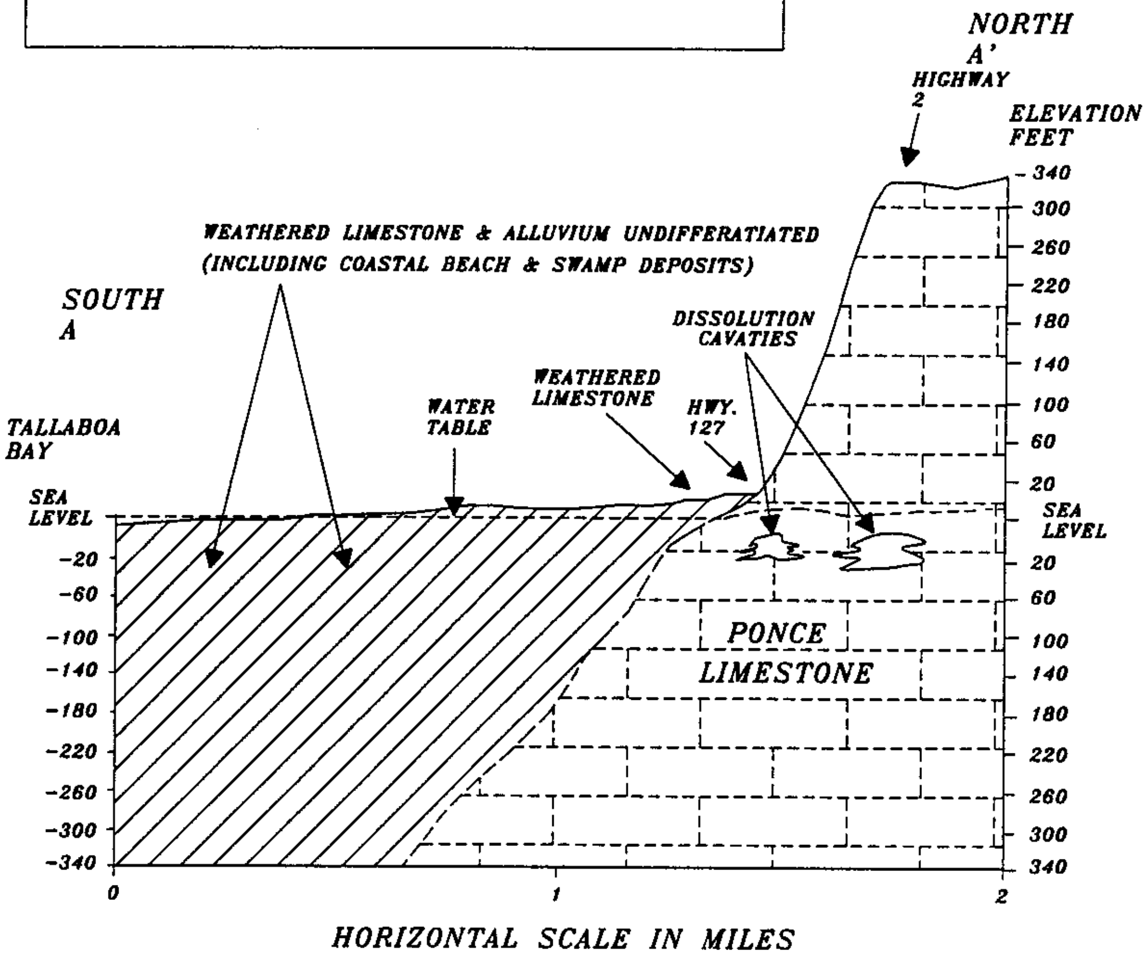
Adapted from U.S. Geological Survey Hydrogeological Map of Puerto Rico and Adjacent Islands (1966)

DSM ENVIRONMENTAL SERVICES, INC.

CORCO SITE AREA
GENERAL GEOLOGIC MAP
PENUELAS, PUERTO RICO

PROJECT: 1035	DRAWN BY: RJC	CHK'D BY: PD	REV: 2
DATE: 5-4-95	SCALE: NTS	FIGURE: 4	DB NUMBER:





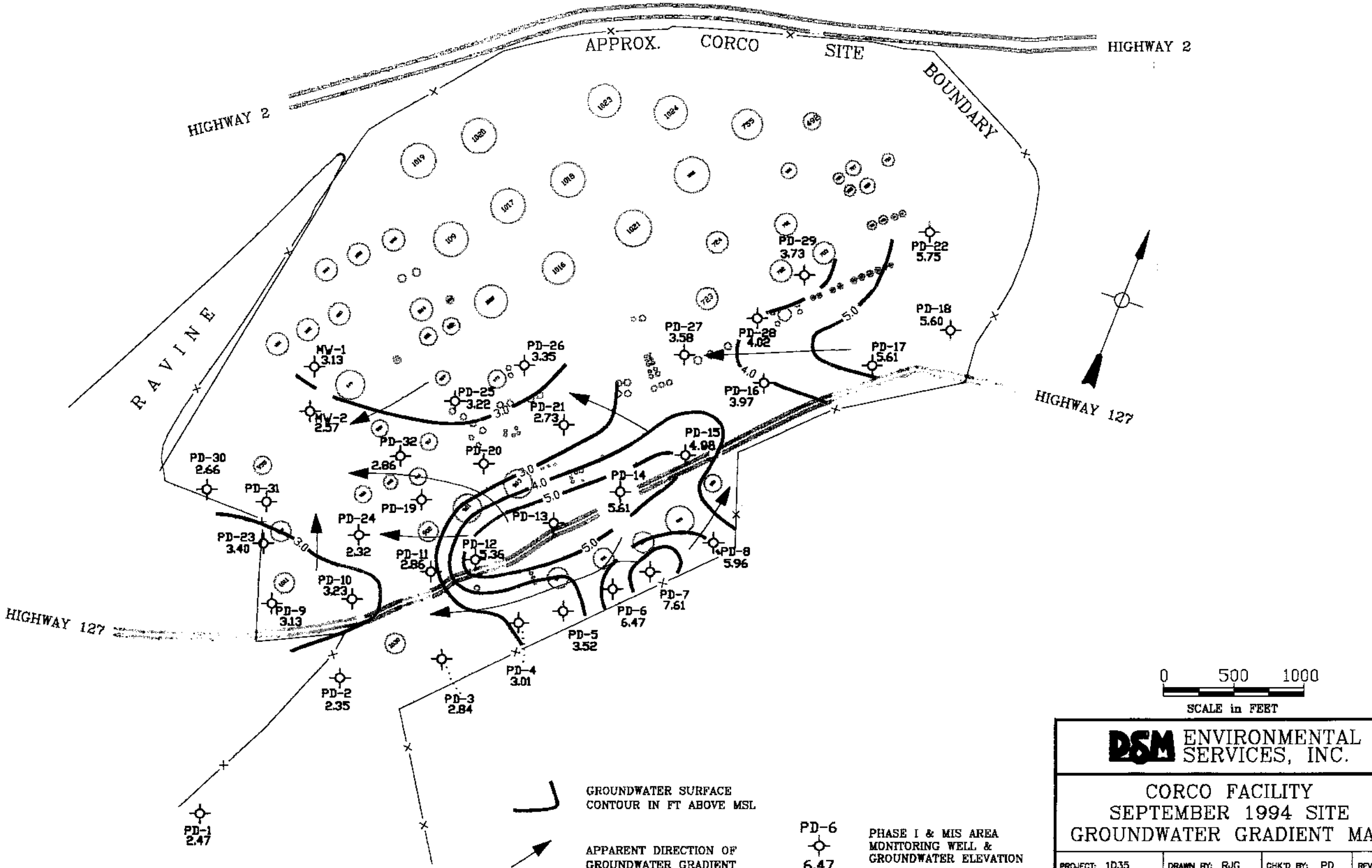
SCALE RATIO $\frac{\text{VERTICAL}}{\text{HORIZONAL}} = \frac{13.5}{1}$

MODIFIED FROM: USGS, 1972

DSM ENVIRONMENTAL SERVICES, INC.

GENERALIZED HYDROGEOLOGIC
CROSS-SECTION
PENUELAS, PUERTO RICO

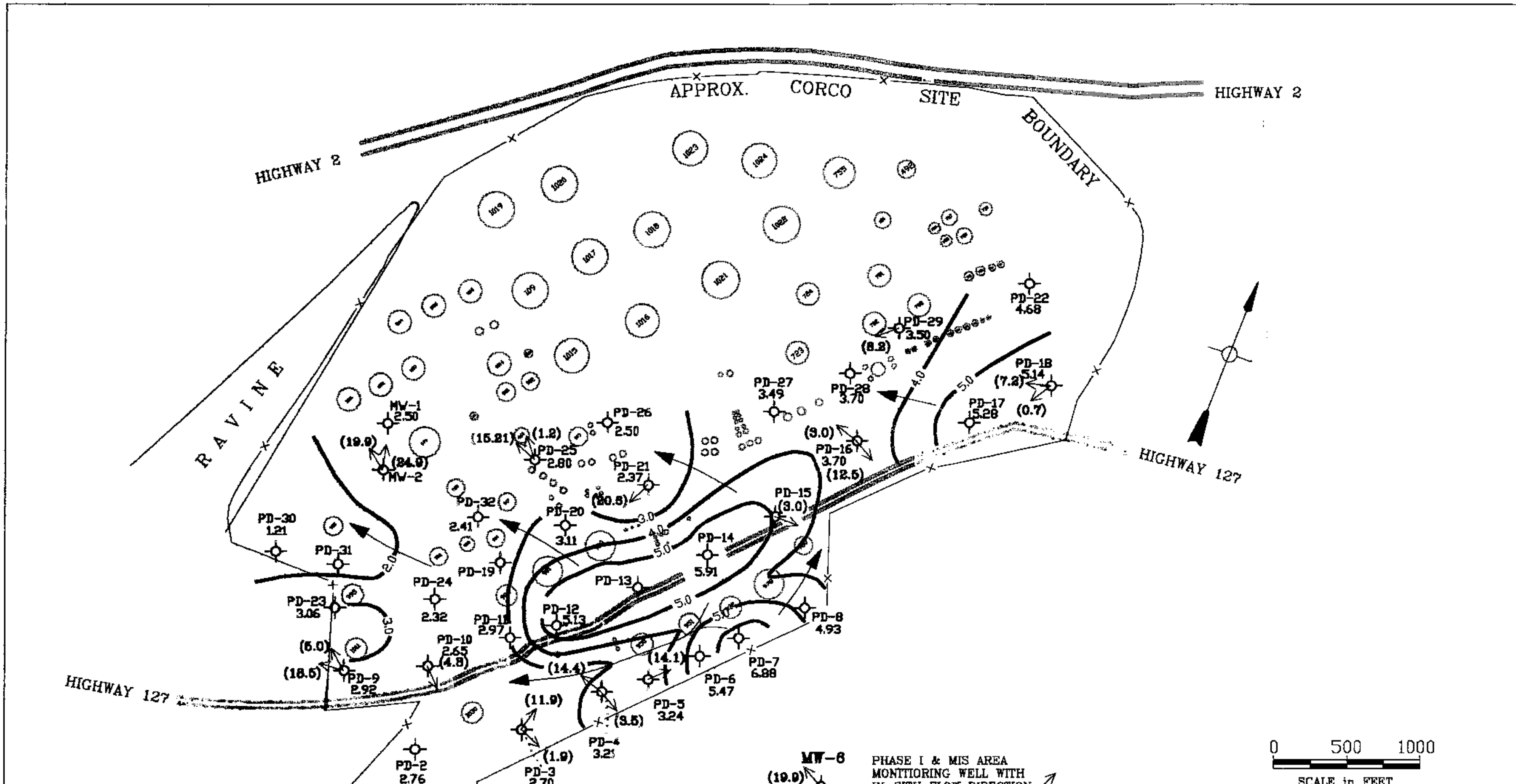
PROJECT: 1035	DRAWN BY: RJC	CHK'D BY: PD	REV: 3
DATE: 1-29-98	SCALE: NTS	FIGURE: 5	DB NUMBER:



DSM ENVIRONMENTAL SERVICES, INC.

CORCO FACILITY
SEPTEMBER 1994 SITE
GROUNDWATER GRADIENT MAP

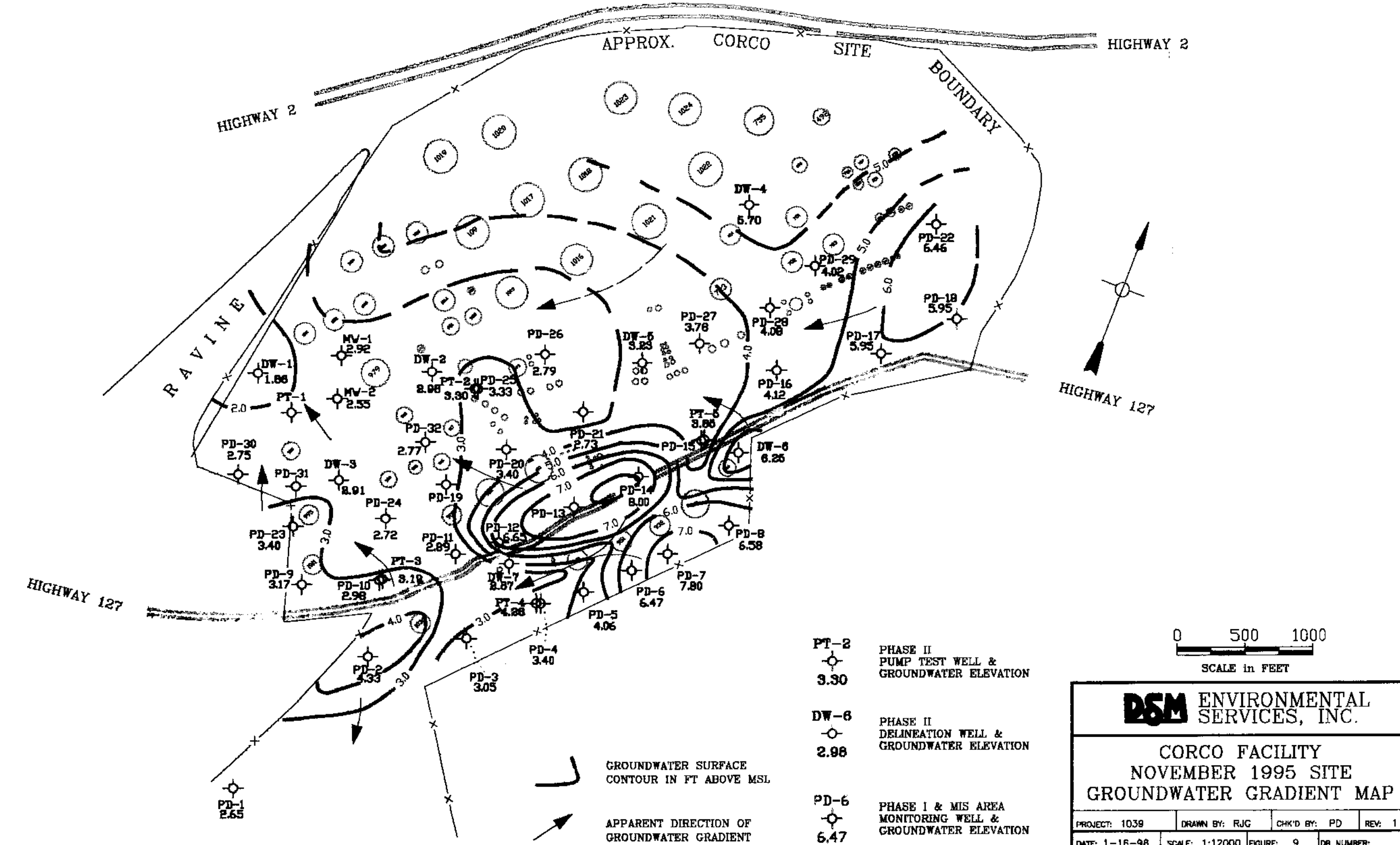
PROJECT: 1D35	DRAWN BY: RJG	CHK'D BY: PD	REV: 1
DATE: 1-17-96	SCALE: 1:12000	FIGURE: 7	DB NUMBER:



DSM ENVIRONMENTAL SERVICES, INC.

CORCO FACILITY
AUGUST 1995 SITE
GROUNDWATER GRADIENT MAP

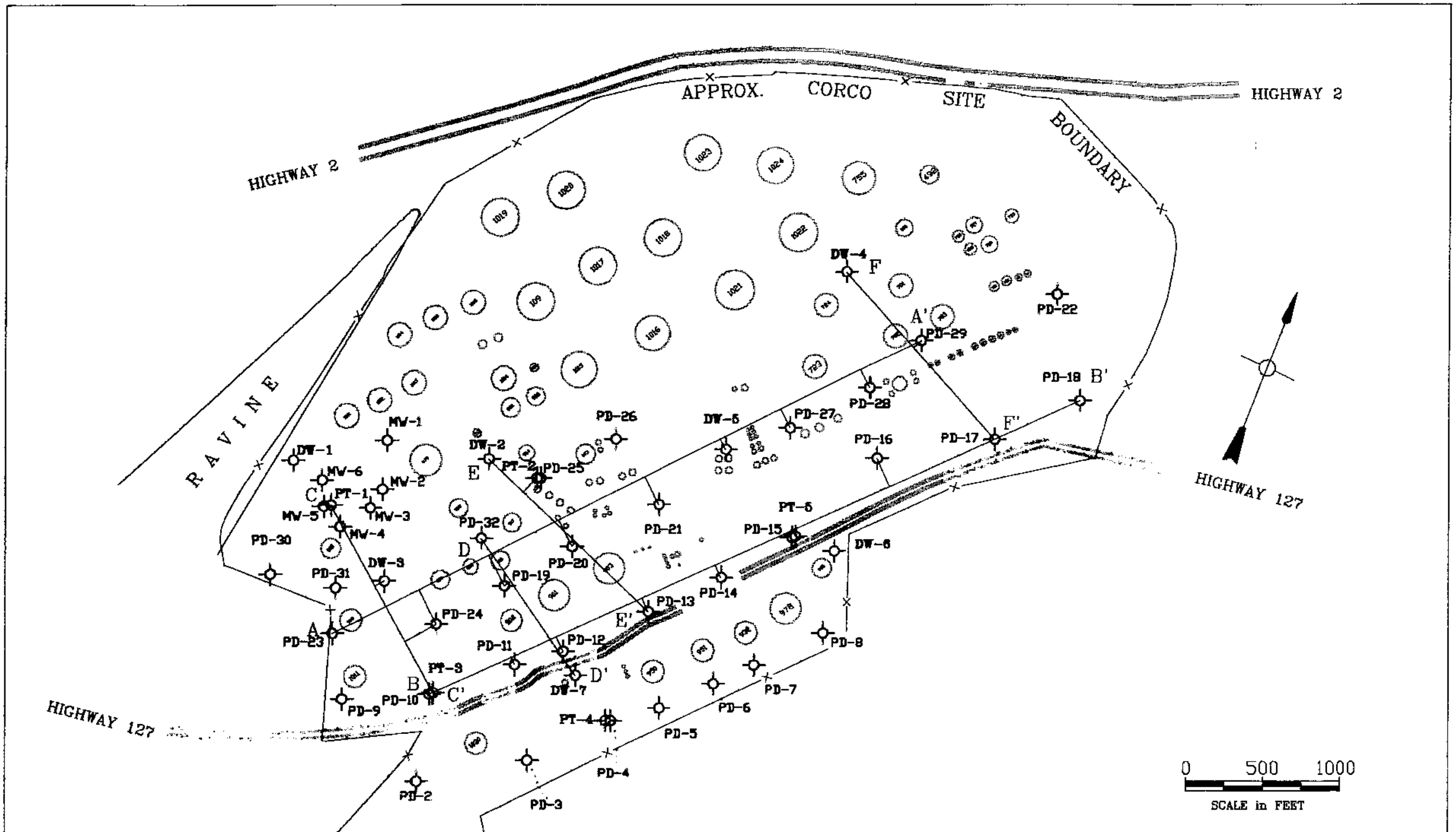
PROJECT: 1035	DRAWN BY: RJG	CHK'D BY: PD	REV: 1
DATE: 1-17-96	SCALE: 1:12000	FIGURE: 8	DB NUMBER:



DSM ENVIRONMENTAL SERVICES, INC.

CORCO FACILITY
NOVEMBER 1995 SITE
GROUNDWATER GRADIENT MAP

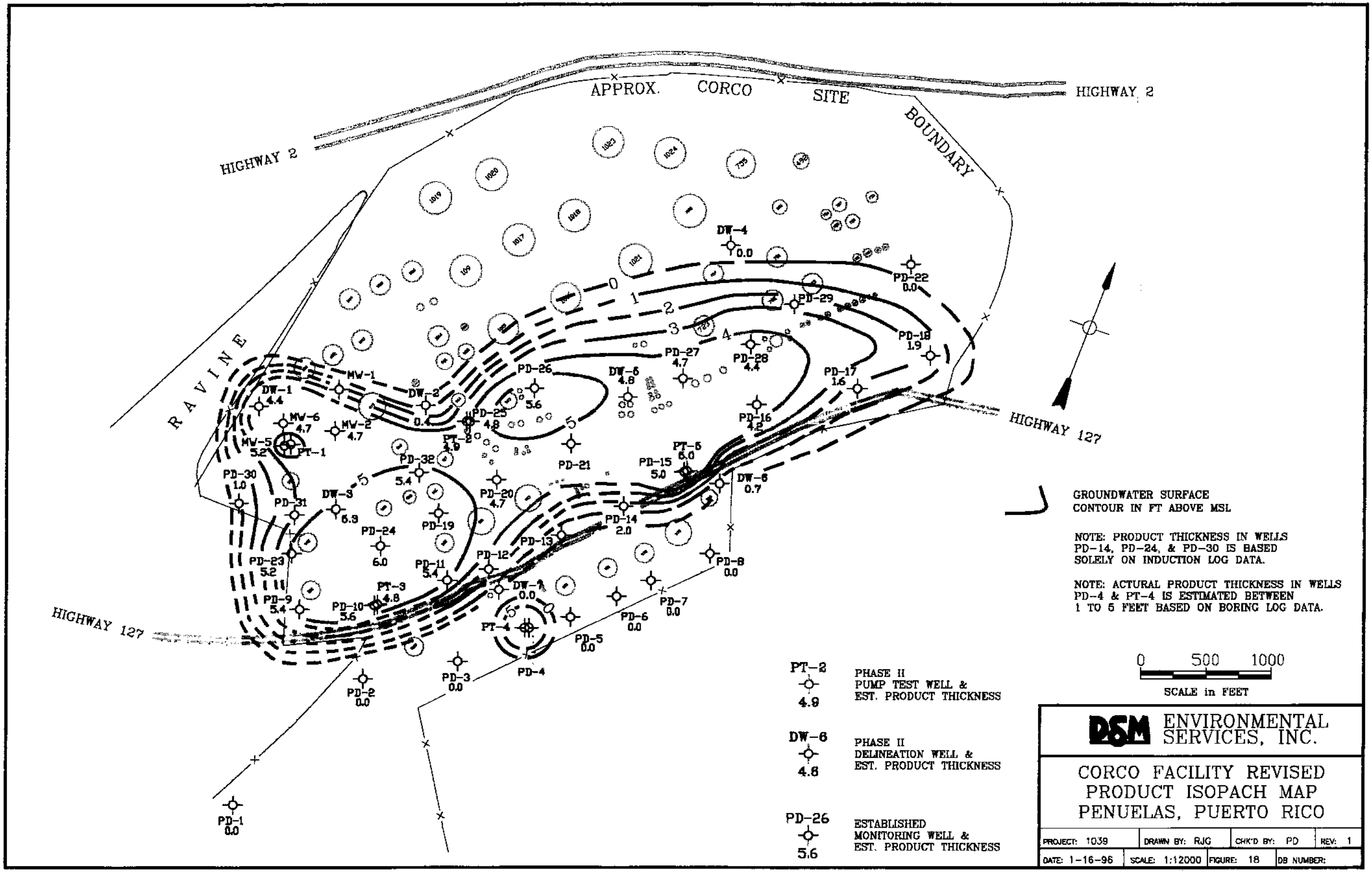
PROJECT: 1039	DRAWN BY: RJG	CHK'D BY: PD	REV: 1	
DATE: 1-16-98	SCALE: 1:12000	FIGURE: 9	DB NUMBER:	



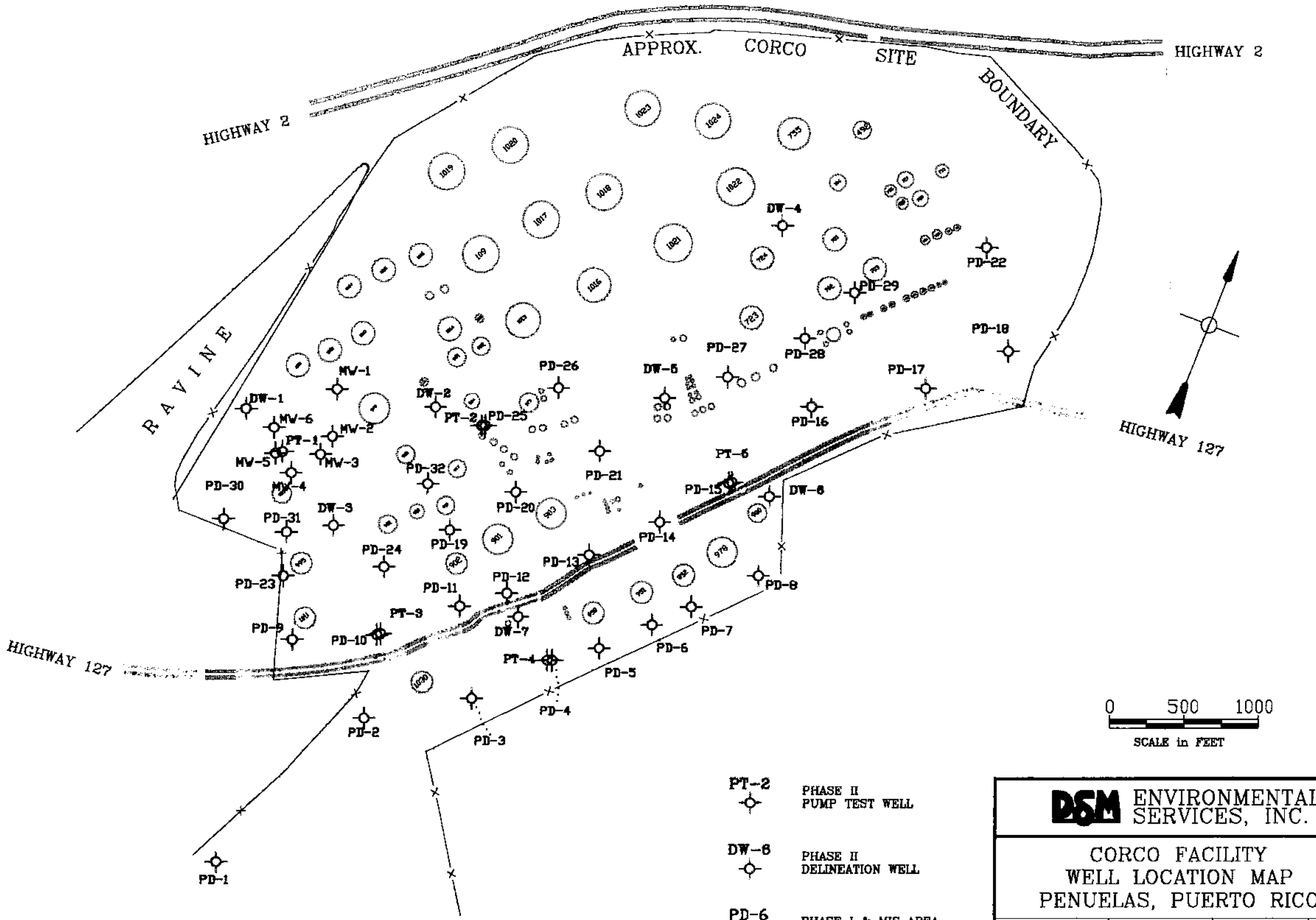
DSM ENVIRONMENTAL SERVICES, INC.

CORCO FACILITY
CROSS-SECTION LOCATION MAP
PENUELAS, PUERTO RICO

PROJECT: 1035	DRAWN BY: RJG	CHK'D BY: PD	REV:
DATE: 1-9-96	SCALE: 1:2000	FIGURE: 10	DB NUMBER:



APPROX. CORCO SITE BOUNDARY
HIGHWAY 2
HIGHWAY 2
HIGHWAY 127
HIGHWAY 127
RAVINE
PD-1 0.0
PD-2 0.0
PD-3 0.0
PD-4
PD-5 0.0
PD-6 0.0
PD-7 0.0
PD-8 0.0
PD-9 5.4
PD-10 5.6
PD-11 5.4
PD-12
PD-13
PD-14 2.0
PD-15 5.0
PD-16 4.2
PD-17 1.6
PD-18 1.9
PD-19
PD-20 4.7
PD-21
PD-22 0.0
PD-23 5.2
PD-24 6.0
PD-25 4.8
PD-26 5.6
PD-27 4.7
PD-28 4.4
PD-29
PD-30 1.0
PD-31
PD-32 5.4
DW-1 4.4
DW-2 0.4
DW-3 6.9
DW-4 0.0
DW-5 4.8
DW-6 0.7
DW-7 0.0
MW-1
MW-2 4.7
MW-5 5.2
MW-6 4.7
PT-1
PT-2 4.9
PT-3 4.8
PT-4
PT-5 6.0
GROUNDWATER SURFACE
CONTOUR IN FT ABOVE MSL
NOTE: PRODUCT THICKNESS IN WELLS PD-14, PD-24, & PD-30 IS BASED SOLELY ON INDUCTION LOG DATA.
NOTE: ACTURAL PRODUCT THICKNESS IN WELLS PD-4 & PT-4 IS ESTIMATED BETWEEN 1 TO 5 FEET BASED ON BORING LOG DATA.
0 500 1000
SCALE in FEET
PT-2 4.9 PHASE II PUMP TEST WELL & EST. PRODUCT THICKNESS
DW-6 4.8 PHASE II DELINEATION WELL & EST. PRODUCT THICKNESS
PD-26 5.6 ESTABLISHED MONITORING WELL & EST. PRODUCT THICKNESS
DSM ENVIRONMENTAL SERVICES, INC.
CORCO FACILITY REVISED
PRODUCT ISOPACH MAP
PENUELAS, PUERTO RICO
PROJECT: 1039
DRAWN BY: RJG
CHK'D BY: PD
REV: 1
DATE: 1-16-96
SCALE: 1:12000
FIGURE: 18
DB NUMBER:



DSM ENVIRONMENTAL SERVICES, INC.

CORCO FACILITY
WELL LOCATION MAP
PENUELAS, PUERTO RICO

PROJECT: 1035	DRAWN BY: RJG	CHK'D BY: PD	REV:
DATE: 1-9-96	SCALE:	FIGURE: 6	DB NUMBER:

IMPLEMENTATION SCHEDULE FIGURE 19

PHASE II – Subsurface Product Delineation & Formation Evaluation Work Plan

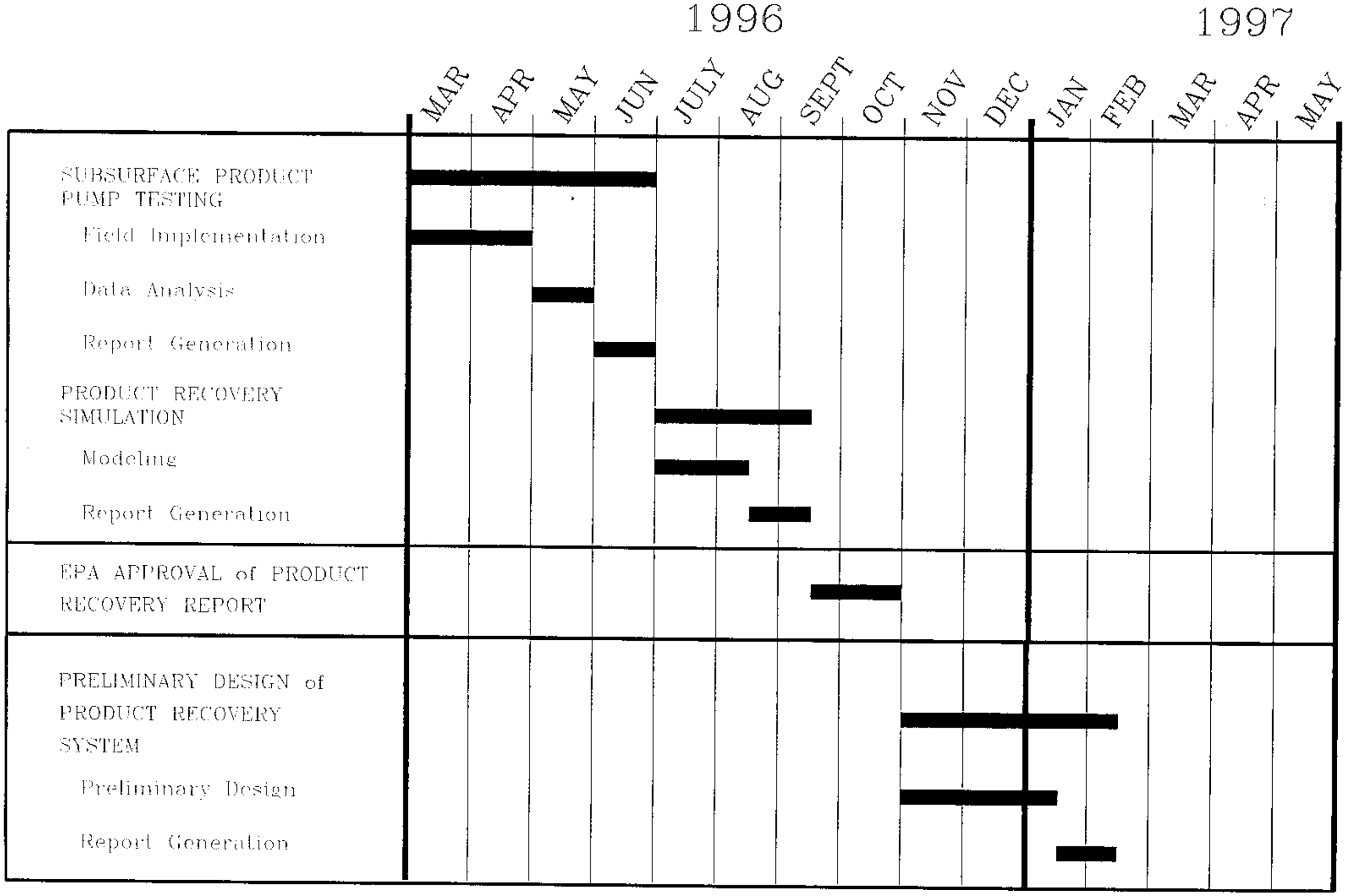


Table 1 September, 1994
Phase I Fluid Elevation Data

Well Number	Top of Casing[1] feet	Depth to Screen ft BTOC[2]	Depth to Product ft BTOC	Depth to Water ft BTOC	APT[3] feet	Adjusted APT[4] feet	Static Water Level feet MSL[5]
MW-02	180.07	190.00*		177.39			2.68
PD-1	7.83	7.84*		5.36			2.47
PD-2	12.26	7.26		9.91			2.35
PD-3	10.78	7.26		7.94			2.84
PD-4	11.73	7.80**	7.03	19.09	12.06	10.37	3.01
PD-5	9.15	7.81*		5.63			3.52
PD-6	11.68	7.81*		5.21			6.47
PD-7	13.26	8.20*		5.65			7.61
PD-8	15.14	7.98		9.18			5.96
PD-9	57.17	54.60**	52.39	62.1	9.71	8.06	3.13
PD-10	39.80	30.83	34.94	45.17	10.23	8.59	3.23
PD-11	35.84	37.31**	31.12	41.44	10.32	8.46	2.86
PD-12	32.76	25.12	27.40	27.4			5.36
PD-13	34.36	11.22		14.72			**19.64**[6]
PD-14	35.70	25.66	29.99	30.64	0.65	0.55	5.61
PD-15	34.65	24.66	28.22	37.3	9.08	7.63	4.98
PD-16	41.09	35.75	35.22	42.82	7.6	5.70	3.97
PD-17	36.59	29.22	30.22	33.69	3.47	2.71	5.61
PD-18	39.93	28.36	33.26	36.85	3.59	2.51	5.60
PD-19	94.15	82.34		83.07			**11.08**
PD-20	82.21	69.96	69.09	77.43	8.34	6.84	**11.62**
PD-21	99.32	110.30*		96.59			2.73
PD-22	168.07	152.00		162.32			5.75
PD-23	90.58	82.28	85.59	94.94	9.35	7.76	3.40
PD-24	103.78	122.62*		101.35			2.43
PD-25	144.39	137.80	139.51	148.71	9.2	7.54	3.22
PD-26	163.99	157.50	159.12	169.27	10.15	8.63	3.35
PD-27	130.05	127.00**	124.65	133.78	9.13	7.30	3.58
PD-28	84.18	76.69	78.09	86.05	7.96	5.89	4.02
PD-29	113.30	110.60*		109.57			3.73
PD-30	83.76	81.49*		81.10			2.66
PD-31	123.08	97.15		115.85			**7.23**
PD-32	158.90	151.20	154.15	164.07	9.92	8.04	2.86

1. Top of casing measurement based on 1995 Phase II Step #1 Survey data.
2. ft BTOC indicates feet below top of casing measurement (taken from Table 4 of Phase I report).
3. APT indicates measured apparent product thickness using dual interface probe.
4. Adjusted APT indicates measured product thickness multiplied by product density.
5. Static water level in feet above mean seal level (ft MSL) was corrected for adjusted APT if applicable.

* indicates water level in well is above top of screen.

** indicates product level in well is above top of screen and water level is below top of screen.

6. Bold values in static water level column are anomolusly high.

Table 2 August, 1995
Phase II Fluid Elevation Data

Well Number	Top of Casing[1] feet	Depth to Screen ft BTOC[2]	Depth to Product ft BTOC	Depth to Water ft BTOC	APT[3] feet	Adjusted APT[4] feet	Static Water Level feet MSL[5]
MW-01	212.44	264.95*		209.94			2.50
MW-02	180.07	190.00*					
PD-1	7.83	7.84*		5.39			2.44
PD-2	12.26	7.26		9.5			2.76
PD-3	10.78	7.26		8.08			2.70
PD-4	11.73	7.80**	6.15	24.38	18.23	15.86	3.21
PD-5	9.15	7.81*		5.91			3.24
PD-6	11.68	7.81*		6.21			5.47
PD-7	13.26	8.20*		6.38			6.88
PD-8	15.14	7.98		10.21			4.93
PD-9	57.17	54.60**	52.55	62.6	10.05	8.34	2.92
PD-10	39.80	30.83	35.18	45.55	10.37	8.40	2.65
PD-11	35.84	37.31**	31.31	39.96	8.65	7.09	2.97
PD-12	32.76	25.12		27.63			5.13
PD-13	34.36	11.22		14.38			**19.98**[6]
PD-14	35.70	25.66	29.70	30.33	0.63	0.54	5.91
PD-15	34.65	24.66	29.46		5.54		
PD-16	41.09	35.75	35.50	43.06	7.56	5.67	3.70
PD-17	36.59	29.22	30.72	33.42	2.70	2.11	5.28
PD-18	39.93	28.36	33.80	37.1	3.30	2.31	5.14
PD-19	94.15	82.34	83.21	83.57	0.36	0.30	**10.88**
PD-20	82.21	69.96	77.55	86.2	8.65	7.09	3.11
PD-21	99.32	110.30*		96.95			2.37
PD-22	168.07	152.00		163.39			4.68
PD-23	90.58	82.28	85.90	95.41	9.51	7.89	3.06
PD-24	103.78	122.62*		101.46			2.32
PD-25	144.39	137.80	139.95	149.05	9.10	7.46	2.80
PD-26	163.99	157.50	159.41	169.81	10.40	8.32	2.50
PD-27	130.05	127.00**	124.91	133.18	8.27	6.62	3.49
PD-28	84.18	76.69	78.41	86.38	7.97	5.90	3.70
PD-29	113.30	110.60*		109.8			3.50
PD-30	83.76	81.49*		82.55			1.21
PD-31	123.08	97.15		113.46			**9.62**
PD-32	158.90	151.20	154.59	164.59	10.00	8.10	2.41

1. Top of casing measurement based on 1995 Phase II Step #1 Survey data.
2. ft BTOC indicates feet below top of casing measurement (taken from Table 4 of Phase I report).
3. APT indicates measured apparent product thickness using dual interface probe.
4. Adjusted APT indicates measured product thickness multiplied by product density.
5. Static water level in feet above mean seal level (ft MSL) was corrected for adjusted APT if applicable.

* indicates water level in well is above top of screen.

** indicates product level in well is above top of screen and water level is below top of screen.

6. Bold values in static water level column are anomolusly high.

Table 3 November, 1995
Phase II Fluid Elevation Data

Well Number	Top of Casing(1) feet	Top of Screen ft BTOC(2)	Depth to Product ft BTOC	Depth to Water ft BTOC	APT(3) feet	Adjusted APT(4) feet	Static Water Level feet MSL(5)
Phase I and MIS Area Monitoring Wells							
MW-01	212.44	264.95*		209.52			2.92
MW-02	180.07	190.00*		177.52			2.55
PD-1	7.83	7.84*		5.18			2.65
PD-2	12.26	7.26		7.93			4.33
PD-3	10.78	7.26		7.73			3.05
PD-4	11.73	7.80**	5.83	25.04	19.21	16.71	3.40
PD-5	9.15	7.81*		5.09			4.06
PD-6	11.68	7.81*		5.21			6.47
PD-7	13.26	8.20*		5.46			7.80
PD-8	15.14	7.98		8.56			6.58
PD-9	57.17	54.60**	52.36	62.01	9.65	8.01	3.17
PD-10	39.80	30.83	34.88	45.08	10.20	8.26	2.98
PD-11	35.84	37.31**	31.02	41.70	10.68	8.76	2.89
PD-12	32.76	25.12		26.11			6.65
PD-13	34.36	11.22		11.92			**22.44**(6)
PD-14	35.70	25.66	27.69	27.77	0.08	0.07	8.00
PD-15	34.65	24.66	29.05		5.95		
PD-16	41.09	35.75	35.00	42.91	7.91	5.93	4.12
PD-17	36.59	29.22	30.13	32.43	2.30	1.79	5.95
PD-18	39.93	28.36	32.98	36.31	3.33	2.33	5.95
PD-19	94.15	82.34		81.52			**12.63**
PD-20	82.21	69.96	77.25	85.91	8.66	7.10	3.40
PD-21	99.32	110.30*		96.59			2.73
PD-22	168.07	152.00		161.61			6.46
PD-23	90.58	82.28	85.58	94.96	9.38	7.79	3.40
PD-24	103.78	122.62*		101.06			2.72
PD-25	144.39	137.80	139.67	147.40	7.73	6.34	3.33
PD-26	163.99	157.50	159.23	169.11	9.88	7.90	2.79
PD-27	130.05	127.00**	124.66	132.73	8.07	6.46	3.78
PD-28	84.18	76.69	78.05	85.94	7.89	5.84	4.08
PD-29	113.30	110.60*		109.28			4.02
PD-30	83.76	81.49*		81.01			2.75
PD-31	123.08	97.15	113.37	113.39			**9.69**
PD-32	158.90	151.20	154.28	163.99	9.71	7.87	2.77

Table 3 November, 1995
Phase II Fluid Elevation Data

Well Number	Top of Casing[1] feet	Top of Screen ft BTOC[2]	Depth to Product ft BTOC	Depth to Water ft BTOC	APT[3] feet	Adjusted APT[4] feet	Static Water Level feet MSL[5]
Phase II Pump Test and Delineation Wells							
PT-1	166.62	144.00		155.79			**10.83**
PT-2	141.52	129.00	136.63	145.50	8.87	7.27	3.30
PT-3	37.11	24.00	32.34	41.10	8.76	7.18	3.19
PT-4	8.70	4.00	4.20	5.91	1.71	1.49	4.28
PT-5	34.90	24.00	29.33	38.38	9.05	7.33	3.85
DW-1	191.14	180.00	187.45	195.41	7.96	6.13	1.86
DW-2	144.88	131.00	141.78	142.45	0.67	0.55	2.98
DW-3	136.56	130.00	131.81	141.45	9.64	7.81	2.91
DW-4	211.64	205.00		205.94			5.70
DW-5	85.00	74.00	80.11	88.86	8.75	7.09	3.23
DW-6	15.00	4.00	8.51	9.80	1.29	1.04	6.24
DW-7	12.65	4.00		9.78			2.87

1. Top of casing measurement based on 1995 Phase II Step #1 Survey data.
2. ft BTOC indicates feet below top of casing measurement (taken from Table 4 of Phase I report).
3. APT indicates measured apparent product thickness using dual interface probe.
4. Adjusted APT indicates measured product thickness multiplied by product density.
5. Static water level in feet above mean seal level (ft MSL) was corrected for adjusted APT if applicable.

* indicates water level in well is above top of screen.

** indicates product level in well is above top of screen and water level is below top of screen.

6. Bold values in static water level column are anomolusly high.

Table 4 Apparent Product Thickness Measurement Data

Well[1] Number	Apparent Product Thickness (ft) Sept. 94	Apparent Product Thickness (ft) 2nd Qtr 1995	Apparent Product Thickness (ft) Aug. 95	Apparent Product Thickness (ft) Nov. 95	Range in Thickness feet (ft) 94-95
Weathered Limestone					
PD-4	12.06		18.23	19.21	7.15
Ponce Limestone					
PD-9	9.71		10.05	9.65	0.40
PD-10	10.23		10.37	10.20	0.17
PD-11	10.32		8.65	10.68	2.03
PD-14	0.65		0.63	0.08	0.57
PD-15[2]	9.08		5.54+	5.95+	
PD-16	7.6		7.56	7.91	0.35
PD-17	3.47		2.70	2.30	1.17
PD-18	3.59		3.30	3.33	0.29
PD-20	8.34		8.65	8.66	0.32
PD-23	9.35		9.51	9.38	0.16
PD-25	9.2		9.10	7.73	1.47
PD-26	10.15		10.40	9.88	0.52
PD-27	9.13		8.27	8.07	1.06
PD-28	7.96		7.97	7.89	0.08
PD-32	9.92		10.00	9.71	0.29
MW-05	10.20	8.58	9.69		1.62

1. Only wells with more than one thickness measurement were used.
2. Well PD-15 has silt in the well and the total apparent thickness could not be determined.

Table 5 Static Water Level Flucuation Data

Well Number	SWL[1] feet MSL[2] Sept. 94	SWL feet MSL Aug. 95	SWL feet MSL Nov.95	Maximum Range feet
MW-02	2.57		2.55	0.02
PD-1	2.47	2.44	2.65	0.21
PD-2	2.35	2.76	4.33	**1.98**
PD-3	2.84	2.70	3.05	0.35
PD-4	3.01	3.21	3.40	0.39
PD-5	3.52	3.24	4.06	0.82
PD-6	6.47	5.47	6.47	1.00
PD-7	7.61	6.88	7.80	0.92
PD-8	5.96	4.93	6.58	**1.65**
PD-9	3.13	2.92	3.17	0.26
PD-10	3.23	2.65	2.98	0.57
PD-11	2.86	2.97	2.89	0.11
PD-12	5.36	5.13	6.65	**1.52**
PD-13	**19.64**	**19.98**	**22.44**	**2.80**
PD-14	5.61	5.91	8.00	**2.39**
PD-15	4.98			
PD-16	3.97	3.70	4.12	0.41
PD-17	5.61	5.28	5.95	0.68
PD-18	5.60	5.14	5.95	0.81
PD-19	**11.08**	**10.88**	**12.63**	**1.75**
PD-20	**11.62**	3.11	3.40	0.29
PD-21	2.73	2.37	2.73	0.36
PD-22	5.75	4.68	6.46	**1.78**
PD-23	3.40	3.06	3.40	0.34
PD-24	2.43	2.32	2.72	0.40
PD-25	3.22	2.80	3.33	0.53
PD-26	3.35	2.50	2.79	0.85
PD-27	3.58	3.49	3.78	0.29
PD-28	4.02	3.70	4.08	0.38
PD-29	3.73	3.50	4.02	0.52
PD-30	2.66	1.21	2.75	**1.54**
PD-31	**7.23**	**9.62**	**9.69**	**2.46**
PD-32	2.86	2.41	2.77	0.46
Average Water Level Flucuation				0.90
Standard Deviation				0.76
Upper 99% Confidence Limit				1.25

1. SWL indicates static water level (was corrected for product where applicable).
2. MSL indicates with respect to mean sea level.

Bold values in cloumns 2, 3 and 4 indicate anomolusly high water elevation values.
Bold values in cloumns 5 indicate values exceed the upper 99% confidence limit.
The 11.62 value for well PD-21 appears to be anomolus and was not used in range calculation.

Table 6 In-situ Fluid Flow Well Data

Well Number	Measured Depth ft BTOC[1]	Measured Depth ft BTOS[2]	Depth Below Top of Fluid feet	Fluid Measured Oil/Water	Apparent Velocity feet/day	Apparent Flow Direction deg. from N	RPD[3] Velocity %	RPD Direction %	Comments
PD-3	10.0	2.7	1.9	Water	0.33	143	35.71	5.76	Well located approximately 20 feet north of cooling water return ditch. Head of water in ditch does not appear to be effecting shallower flow.
PD-3D	10.0	2.7	1.9	Water	0.23	135			Duplicate measurement, see cell above.
PD-3	20.0	12.7	11.9	Water	1.17	32	75.29	74.51	Overall least accurate measurements in spread sheet based on RPDs. Velocity incresing with depth; head of water in cooling water return ditch may be locally effecting flow.
PD-3D	20.0	12.7	11.9	Water	0.53	70			Duplicate measurement, see cell above.
PD-4	10.5	2.7	4.4	Oil	0.40	131	11.76	3.89	Well located approximately 20 feet north of cooling water return ditch. Head of water in ditch does not appear to be effecting shallower flow.
PD-4D	10.5	2.7	4.4	Oil	0.45	126			Duplicate measurement, see cell above.
PD-4	20.5	12.7	14.4	Oil	1.89	317	11.47	0.32	Probe in oil, formation probably water wet only based on logs and offset boring data. Velocity incresing with depth appears high for a calcareous clay; head of water in cooling water return ditch may be locally effecting flow.
PD-4D	20.5	12.7	14.4	Oil	2.12	316			Duplicate measurement, see cell above.
PD-5	20.0	12.2	14.1	Water	0.38	85	31.11	30.00	Well located approximately 100 feet southeast of cooling water return ditch. Head of water in ditch may be locally effecting flow.
PD-5D	20.0	12.2	14.1	Water	0.52	115			Duplicate on north measurement only, see cell above.
PD-9	57.5	2.9	5.0	Oil	1.18	354			Large ravine located west and northwest of well may be effecting flow in this area of the site.
PD-9	71.0	16.4	18.5	Water	0.23	276			Large ravine located west and northwest of well may be effecting flow in this area of the site. Flow is non-linear
PD-10	40.0	9.2	4.8	Oil	1.39	148	14.67	5.90	Flow following gradient contour map and steep slope to south.
PD-10D	40.0	9.2	4.8	Oil	1.61	157			Flow following gradient contour map and steep slope to south.
PD-15	32.5	7.8	3.0	Oil	2.27	114	0.00	4.48	Groundwater high to west may be resulting in flow toward east at this location.
PD-15D	32.5	7.8	3.0	Oil	2.27	109			Duplicate measurement, see cell above.
PD-16	38.5	2.8	3.0	Oil	0.37	281	61.68	24.38	Note lower velocities coincide with the groundwater gradient map which indicates a groundwater high to the east and west and that the groundwater high to east may be resulting in flow toward west at this location.
PD-16D	38.5	2.8	3.0	Oil	0.70	359			Duplicate measurement, see cell above.
PD-16	48.0	12.3	12.5	Water	0.97	120			Note lower velocities coincide with the groundwater gradient map which indicates a groundwater high to the east and west. It appears with depth that the high to the west is effecting flow at a lower level in this well.

Table 6 *In-situ* Fluid Flow Well Data

Well Number	Measured Depth ft BTOC(1)	Measured Depth ft BTOS(2)	Depth Below Top of Fluid feet	Fluid Measured Oil/Water	Apparent Velocity feet/day	Apparent Flow Direction deg. from N	RPD(3) Velocity %	RPD Direction %	Comments
PD-18	34.5	6.1	0.7	Oil	0.32	254			Lack of control to the east makes interpretation difficult, however, there appears to be similarities with measurements made in wells PD 15 and 16 which are also located along the groundwater mounding trend. Non-linear flow.
PD-18	41.0	12.6	7.2	Water	0.38	266			Lack of control to the east makes interpretation difficult, however, there appears to be similarities with measurements made in wells PD 15 and 16 which are also located along the groundwater mounding trend.
PD-21	117.5	7.2	20.6	Water	0.94	240			Water level in this well is anomoulously high and may be effected by seepage from an overlying perched water table.
PD-25	141.0	3.2	1.2	Oil	3.79	351	13.30	2.31	Highest flow velocities measured on site were in this oil zone. Note that solution cavities were present at this interval during drilling and may account for the increase velocities. Mounding effect appears to be effecting flow direction.
PD-25D	141.0	3.2	1.2	Oil	4.33	343			Duplicate measurement, see cell above.
PD-25	155.0	17.2	15.2	Water	1.18	321	32.62	0.63	Flow velocities lower with depth, velocity interval below noted solution cavity zone. Mounding effect appears to be effecting flow direction.
PD-25D	155.0	17.2	15.2	Water	1.64	319			Duplicate measurement, see cell above.
PD-29	118.0	7.4	8.2	Water	1.12	246	5.22	7.16	Flow velocities in-line with other velocity measurements. Mounding effect appears to be effecting flow direction.
PD-29	118.0	7.4	8.2	Water	1.18	229			Duplicate south measurement only, see cell above.
MW-02	197.0	7.0	19.4	Water	0.13	320	60.00	3.17	Lowest flow levels measured on site, gradient map indicates flat area with reversal from mounding effect to regional flow, deep ravine located approximately 700 to north-northwest and gradient reversal from mounding appear to be effecting flow direction.
MW-02D	197.5	7.5	19.9	Water	0.07	310			Duplicate measurement, see cell above. Non-linear flow.
MW-02	202.5	12.5	24.9	Water	0.32	13			Flow velocities increasing with depth, deep ravine to north-northwest appears to be effecting flow.
MW-05	175.5	7.5	12.3	Water	1.30	268			Measured flow velocities at MW-05 greater than MW-02. Deep ravine is located approximately 100 feet to west of MW-05 and appears to be controlling flow direction. Non-linear flow.

Table 7
Product Density and Viscosity Data

Well Number	API Gravity Phase 1 @ 60° F	Specific Gravity Phase 1 @ 60° F	API Gravity Aug. 95 @ 60° F	Specific Gravity Aug. 95 @ 60° F	Viscosity Data centistokes
PD-4	32.70	0.86	31.7	0.87	3.23
PD-9	39.00	0.83			
PD-10	37.90	0.84	43.5	0.81	0.72
PD-11	40.90	0.82			
PD-14	34.10	0.85			
PD-15	36.00	0.84	43.0	0.81	0.66
PD-16	56.50	0.75			
PD-17	50.30	0.78			
PD-18	71.60	0.70			
PD-20	40.40	0.82			
PD-25	40.20	0.82			
PD-26	35.90	0.85	45.1	0.80	0.86
PD-27	44.80	0.80			
PD-28	58.70	0.74			
PD-29	60.80	0.74			
PD-32	42.80	0.81			
MIS (Tank 501 B)			52.0	0.77	0.64

Table 8 Petrophysical Core Data

Well Number	Sample Number	Sample Depth feet	Porosity %	Kl[1] md[4]	k[2] ft/day	Kair[3] md	Saturation		Grain Density g/cm^3
							Oil	Water	
							% Pore Volume		
PT-2	1	141	22.8	*	*	*	6.4	77.9	2.72
	2	160	22.6	1.25	0.0030	1.84	0.0	90.3	2.72
PT-3	3	33	27.3	621.60	1.5105	638.40	6.3	57.3	2.71
	4	38	24.6	235.90	0.5732	385.20	4.0	58.1	2.72
	5	45	23.5	5.29	0.0129	7.20	0.0	84.0	2.71
PT-5	6	19	12.6	3.17	0.0077	3.45	1.3	27.3	2.72
	7	28	13.3	10.20	0.0248	12.32	0.0	81.7	2.71
	8	29	21.6	37.06	0.0901	44.16	0.1	71.9	2.70
	9	31	11.9	0.77	0.0019	1.12	0.0	72.5	2.70
	10	38	13.5	0.58	0.0014	0.65	0.5	86.0	2.71
	11	49	13.8	164.40	0.3995	257.40	0.8	67.2	2.71

1. Kl = Klinkenberg permeabilty or permeability with respect to the fluid phase.
2. k = hydraulic conductivity
3. Kair = permeability with respect to air.
4. md = millidarcy (note that one millidarcy equals 2.43 x 10^{-3} ft/day)

* indicates sample was not suitable (poorly cemented) for permeability measurement.

TABLE 9A *Induction Log Evaluation Data - Weathered Limestone Unit*

Well No.	Total Depth Well feet bgs Phase II	Total Depth Induction Log feet bgs Phase II	Elevation Product feet bgs Phase II	Elevation Water feet bgs Phase II	Screen Elev. feet bgs Phase II	APT[1] in Well feet Phase II	EPT[2] from Log feet Phase II	Comments
PD-1	19.78	19.6	NA	2.57	5.02	0.0	ND[3]	E-Log response similar in wells PD-1 through PD-7, screen set below top of fluid level, product not observed while drilling. Conductivity peak may represent zone of maximum water saturation in clay.
PD-2	20.67	18.6	NA	7.27	4.93	0.0	ND	E-Log response similar in wells PD-1 through PD-7, screen set above fluid level, product not observed while drilling. Conductivity peak may represent zone of maximum water saturation in clay.
PD-3	21.68	22.4	NA	5.16	4.34	0.0	ND	E-Log response similar in wells PD-1 through PD-7, screen set above fluid level, product not observed while drilling. Conductivity peak may represent zone of maximum water saturation in clay.
PD-4	23.83	22.3	3.30	21.53	4.95	18.2	ND	E-Log response similar in wells PD-1 through PD-7, screen set high enough, during drilling product was noted at 11 feet bgs in PD-4 and at 10 feet bgs in ofset pump test well (PT-4), product thickness increasing with time, < 2 feet of product in PT-4.
PD-5	25.40	23.6	NA	3.29	5.19	0.0	3.5	E-log appears to indicate product bearing zone associated with suppressed conductivity response at 11 to 14.5 ft bgs in zone of maximum water saturation, screen set below top of fluid level, product not observed while drilling .
PD-6	21.52	19.7	NA	3.95	5.55	0.0	0.0	E-log response similar in well PD-1 through PD-7, screen set below top of fluid level, hydrocarbon staining and visible hydrocarbons (no product bearing zone) were noted during drilling.
PD-7	25.99	23.9	NA	3.95	5.77	0.0	ND	E-Log response similar in wells PD-1 through PD-7, screen set below top of fluid level, product not observed while drilling. Conductivity peak may represent zone of maximum water saturation in clay.
PD-8	18.34	16.6	NA	7.59	5.36	0.0	0.0	Low conductivity induction response corresponds with low formation water conductivity measurement, product was not observed during drilling, however, some hydrocarbon staining was noted.

1. APT indicates apparent product thickness based on well measurements.
2. EPT indicates estimated product thickness based on induction log interpretation.
3. ND indictes value not determined from induction logging.

Table 9B Induction Log Evaluation Data - Ponce Limestone

Well No.	Total Depth Well feet bgs Phase II	Total Depth Induction Log feet bgs Phase II	Elevation Product feet bgs Phase II	Elevation Water feet bgs Phase II	Screen Elevation feet bgs Phase II	APT(1) in Well feet Phase II	EPT(2) from Log feet Phase II	Comments
PD-9	72.88	69.0	49.43	59.48	51.48	10.1	5.0	Perched water zone identified just above water table, product noted at and below 60 feet bgs during drilling, potentially residual product in vadose zone.
PD-10	44.61	42.4	31.87	42.24	27.52	10.4	4.4	Possible perched water zone above water table induction log response flattened, offset pump test well (PT-3) produced hydrocarbons at 33 feet bgs, product noted at and below 33 feet bgs during drilling, potentially residual product in vadose zone.
PD-11	55.75	48.4	29.64	38.29	35.64	8.7	ND(3)	Interlayered clay logged in zone of saturatation may be masking product zone response, screen set above water level and below product level, product noted at and below 35 feet bgs during drilling, potentially residual product in vadose zone.
PD-12	35.68	34.6	NA	24.45	21.94	0.0	ND	Appears to some residual product saturation in capillary fringe @ 20 to 21 ft bgs, product noted during drilling in staurated zone at 35 to 36 feet bgs below 4 ft clay layer which is not entering screen, potentially residual product in vadose zone.
PD-13	24.90	22.0	NA	11.10	7.94	0.0	0.0	Two perched water zones identified with induction log corresponds with drilling observations, product noted 16 to 25 and at 27 feet bgs during drilling, potentially residual product in vadose zone.
PD-14	39.02	31.0	27.14	27.77	23.10	0.6	2.0	Perched water zone identified just above water table may be effecting product accumulation in well, additional perched water zone in vadose zone, product noted at 38.5 to 41.5 feet bgs during drilling, potentially residual product in vadose zone.
PD-15	35.07	33.9	29.53	NA	24.73	9.0	ND	Oil water contact appears to be at 32 ft bgs, product noted below 32 feet in this well and in pump test off-set well, apparent product thickness based on offset pump test well PT-5, potentially residual product in vadose zone.
PD-16	50.61	39.1	32.25	39.81	32.50	7.6	ND	Perched water zone at top of saturation zone appears to be masking product response, product was noted at 35 to 44 feet bgs during drilling, potentially residual product in vadose zone.
PD-17	42.14	28.5	27.64	30.34	26.14	2.7	ND	Could not log deep enough to determine oil water contact, product noted at 30 feet bgs during drilling, potentially residual product in vadose zone.

Table 9B Induction Log Evaluation Data - Ponce Limestone

Well No.	Total Depth Well feet bgs Phase II	Total Depth Induction Log feet bgs Phase II	Elevation Product feet bgs Phase II	Elevation Water feet bgs Phase II	Screen Elevation feet bgs Phase II	APT[1] in Well feet Phase II	EPT[2] from Log feet Phase II	Comments
PD-18	40.47	35.4	30.49	33.79	25.05	3.3	2.0	Elevated conductivity peak at top of oil bearing zone masking product response, oil water contact is estimated at base of log (+2 ft), product noted at 30 to 32 feet bgs during drilling, potentially residual product in vadose zone.
PD-19	95.47	81.3	80.88	81.24	80.01	0.4	ND	Could not lower sonde into screen, top of screen set at fluid level, product was noted at 85 feet bgs during drilling, thin layer of product detected in well during August, 1995 fluid level measurements.
PD-20	94.42	84.3	77.35	86.00	69.76	8.7	ND	Increase water saturation at top of fluid level effecting product response, could not lower sonde far enough into screen to determine oil/water contact (+3 ft), product noted during drilling at 85 feet bgs, potentially residual product in vadose zone.
PD-21	123.52	120.4	NA	93.57	106.92	0.0	ND	Interlayered clay at top of saturated zone maybe masking product response, screen set below fluid level, no product noted during drilling, potentially residual product in vadose zone noteably above perched water zones.
PD-22	176.86	154.7	NA	159.35	147.96	0.0	ND	Could not log into saturated zone, stick-up slightly bent - could not lower gamma sonde into well casing, no product was observed while drilling, no product in well, potentially residual product in vadose zone.
PD-23	103.88	82.5	82.78	92.29	79.16	9.5	ND	Possible oil/water contact at base of resistivity log, product noted at 80 to 90 feet during drilling, potentially residual product in vadose zone.
PD-24	135.35	117.0	NA	98.61	119.77	0.0	6.0	Product response from 103.5 to 109.5 ft bgs, screen set below fluid level, product was not noted during drilling, potentially residual product in vadose zone.
PD-25	167.28	135.9	136.83	145.93	134.68	9.1	ND	Could not log deep enough to determine oil water contact, product noted at 140 feet bgs during drilling, product produced in offset pump test well PT-2 at 140 foot connection, 9 feet of product in offset well, potentially residual product in vadose zone.
PD-26	174.21	155.0	156.72	167.12	154.81	10.4	ND	Could not log into saturated zone, stick-up slightly bent - could not lower gamma sonde into well, product noted at 160 and 165 feet bgs during drilling, potentially residual product in vadose zone.

Table 9B Induction Log Evaluation Data - Ponce Limestone

Well No.	Total Depth Well feet bgs Phase II	Total Depth Induction Log feet bgs Phase II	Elevation Product feet bgs Phase II	Elevation Water feet bgs Phase II	Screen Elevation feet bgs Phase II	APT[1] in Well feet Phase II	EPT[2] from Log feet Phase II	Comments
PD-27	145.63	124.6	122.84	131.11	124.93	8.3	6.0	Estimate log just to oil/water contact, increase in water saturation just oabove product zone coinciding with clay layer, screen set below top of product level, potentially residual product in vadose zone.
PD-28	98.07	81.7	75.65	83.62	73.93	8.0	ND	Could not log deep enough to determine oil/water contact, product was noted at 80 and 90 feet bgs during drilling, potentially residual product in vadose zone.
PD-29	121.39	109.4	NA	107.04	107.84	0.0	ND	Induction sonde housing cracked at shorted out at fluid level contact, product noted at 115 feet bgs during drilling, top of screen set at fluid level surface, potentially residual product in vadose zone.
PD-30	95.91	90.5	NA	79.66	78.60	0.0	2.0	Producted logged depth appears to be from 75 to 77 feet above the top of screen, product noted at 80 and 85 feet bgs during drilling, top of screen set just above water level, potentially residual product in vadose zone.
PD-31	116.30	96.5	NA	110.31	94.00	0.0	ND	Could not lower e-log sonde into screen below fluid level, product noted at 110 feet bgs during drilling, potentially residual product in vadose zone.
PD-32	173.81	150.4	151.60	161.60	148.21	10.0	ND	Could log deep enough to identify oil/water contact, product was noted at 155 feet bgs during drilling, potentially residual product in vadose zone.
DW-3	155.00	150.7	131.81	141.45	148.21	9.6	4.0	E-log sonde lowered close to base of well, oil/water contact appears to be at approximately 135 feet bgs.

1. APT indicates apparent product thickness based on well measurements.
2. EPT indicates estimated product thickness based on induction log interpretation.
3. ND indictes value not determined from induction logging.

Table 10 Estimated Product Thickness Based on Induction Logging Data

Well Number	APT[1] feet Sept. 94	APT feet 2nd Qtr 95	APT feet Aug. 95	APT feet Nov. 95	Ave.[2] APT feet	EPT[3] feet	Ratio EPT to Ave. APT	*Ave. APT x Ave. EPT/APT Ratio*
MW-03	8.63				8.63			*4.7*
MW-04	6.96				6.96			*3.8*
MW-05	10.20	8.58	9.69		9.49			*5.2*
MW-06	7.98				7.98			*4.4*
PD-9	9.71		10.05	9.65	9.80	5.80	0.59	*5.4*
PD-10	10.23		10.37	10.20	10.27	4.40	0.43	*5.6*
PD-11	10.32		8.65	10.68	9.88			*5.4*
PD-14	0.65		0.63	0.08	0.45	2.00	*	*
PD-15	9.08				9.08			*5.0*
PD-16	7.60		7.56	7.91	7.69			*4.2*
PD-17	3.47		2.70	2.30	2.82			*1.6*
PD-18	3.59		3.30	3.33	3.41	2.00	0.59	*1.9*
PD-20	8.34		8.65	8.66	8.55			*4.7*
PD-22	0.00		0.00	0.00	0.00			*0.0*
PD-23	9.35		9.51	9.38	9.41			*5.2*
PD-25	9.20		9.10	7.73	8.68			*4.8*
PD-26	10.15		10.40	9.88	10.14			*5.6*
PD-27	9.13		8.27	8.07	8.49	6.00	0.71	*4.7*
PD-28	7.96		7.97	7.89	7.94			*4.4*
PD-32	9.92		10.00	9.71	9.88			*5.4*
PT-2				8.87	8.87			*4.9*
PT-3				8.76	8.76			*4.8*
PT-5				9.05	9.05			*5.0*
DW-1				7.96	7.96			*4.4*
DW-2				0.67	0.67			*0.4*
DW-3				9.64	9.64	4.00	0.41	*5.3*
DW-4				0.00	0.00			*0.0*
DW-5				8.75	8.75			*4.8*
DW-6				1.30	1.30			*0.7*
DW-7				0.00	0.00			*0.0*
Average ratio of EPT to Average APT							0.55	

1. APT indicates measured apparent product thickness.
2. Ave. indicates average.
3. EPT indicates estimated product thickness based on induction logging data (see Table 9B).

* indicates that ratio was not calculated since a perched water zone appears to be effecting the APT.

Table 11 Groundwater Conductivity/Salinity Data

Well Number	Conductivity mS/m Field Probe Sept. 94	Conductivity mS/m Field Probe Nov. 95	Conductivity mS/m Analysis Aug. 95	NaCl ppm Analysis Aug. 95	Ratio NaCl/ Conductivity Aug. 95	Average or Interpolated NaCl ppm
PD-1	878.40	660.00				4092.14
PD-2	636.60	1010.00				4379.96
PD-3	4262.00	430.00				12480.72
PD-4			5655.00	27111.00	4.79	14805.70
PD-5	2592.00	1520.00	1898.00	10081.00	5.31	9083.70
PD-6	1020.00	1030.00				5453.00
PD-7	373.40	260.00				1684.84
PD-8	416.00	190.00				1611.96
PD-9		490.00				2606.80
PD-10		410.00				2181.20
PD-11*						2400.00
PD-12		510.00	546.00	3427.00	6.28	2713.20
PD-13	727.60					3870.83
PD-14		500.00	377.00	1731.00	4.59	2195.50
PD-15		410.00				2181.20
PD-16*						2400.00
PD-17		270.00				1436.40
PD-18		280.00				1489.60
PD-19	1978.00	1580.00				9464.28
PD-20						8400.00
PD-21	1243.40	1340.00	1183.00	7592.00	6.42	7360.40
PD-22	673.50					3583.02
PD-23*						4000.00
PD-24	1574.40	840.00				6422.30
PD-25		260.00				1383.20
PD-26*						1500.00
PD-27*						6000.00
PD-28		740.00				3936.80
PD-29		810.00				4309.20
PD-30		280.00				1489.60
PD-31*						1500.00
PD-32*						2000.00
MW-1			190.70	865.00	4.54	865.00
DW-3		940.00				5000.80
Average of NaCl/Conductivity Ratio					5.32	

* indicates that salinity (NaCl) values were interpolated where field samples were not collected.

Table 12 Volume Estimate of In-Place Oil

Contoured Area	Actual Acres per Area	Actual SQFT per Area	Average Oil Thickness per Area	Bulk Volume CFT per Area	Liquid Volume CFT Porosity = 40%	Liquid Volume Gallons 7.481gal/cft	Oil Volume Gallons So = 25%	Actual Oil Volume Barrels 0.02381bar/gal
Ponce Limestone								
0 to 1 ft	36.0	1,568,160.0	0.5	784,080.0	313,632.0	2,346,281.0	586,570.2	13,966.2
1 to 2 ft	31.0	1,350,360.0	1.5	2,025,540.0	810,216.0	6,061,225.9	1,515,306.5	36,079.4
2 to 3 ft	30.0	1,306,800.0	2.5	3,267,000.0	1,306,800.0	9,776,170.8	2,444,042.7	58,192.7
3 to 4 ft	32.0	1,393,920.0	3.5	4,878,720.0	1,951,488.0	14,599,081.7	3,649,770.4	86,901.0
4 to 5 ft	63.8	2,779,128.0	4.5	12,506,076.0	5,002,430.4	37,423,181.8	9,355,795.5	222,761.5
5 to 6 ft	41.2	1,794,672.0	5.5	9,870,696.0	3,948,278.4	29,537,070.7	7,384,267.7	175,819.4
Weathered Limestone/CalcareousClay								
0 to 5ft	3.1	135,036.0	2.5	337,590.0	135,036.0	1,010,204.3	252,551.1	6,013.2
Totals	234.0	10,328,076.0	NA	33,669,702.0	13,467,880.8	100,753,216.3	25,188,304.1	599,733.5

1. Note that the porosity is estimated at 40% based on core and literature data.
2. Also note that the Oil Saturation So is estimated at 25% based on induction logging water saturation calculations.

APPENDIX A-1
COMPLETED FIELD BORING LOGS

BORING LOG

WELL NUMBER: PT-1

LOCATION: 7 FT N of MW-05 MIS AREA

SURFACE ELEVATION: 167 ft MSL

DRILLING COMPANY: Hydrologic

DRILLER: Tony Hobson

LOG BY: Pete Dotsey-DSM

OWNER: CORCO

FACILITY: Penuelas

TOTAL DEPTH: 169 ft bgs

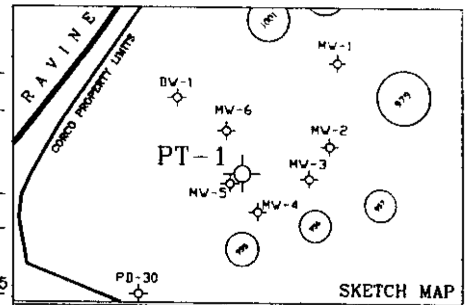
WATER LEVEL: 156 ft bgs

DRILLING METHOD: Dual-Tube Rev. Air

DATE DRILLED: 10/25/95

HELPER: Morris Harrigan

WEATHER: Warm, Breezy, Sunny to cloudy 80's to 90's.



NOTES: MIS Area
± 7 ft. North MW05

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
0				Limestone(Ls)-brown 0 to 4 feet, tan to buff below 4 feet, dry
				gravel to silt size Ls clasts in returns, no Hydrocarbon(HC)
	0	1		odor, no stain, driller notes Ls is soft and friable
10	0	2		
				Bit plugged at 10 feet soft calcareous clay damp,
				tan to buff, pulled out of hole (POOH) clear bit.
	0	3		
20	0	4		
				Ls - as above(A/A), some areas more friable -
	0	5		grinds up to flour/fine grain powder.
30	0	6		Ls - A/A
	0	7		
40	0	8		Ls - A/A

BORING ID No. PT-1

SHEET 1 OF 4

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
40	0	8		
				Ls - A/A
	0	9		
50	0	10		
	0	11		
60	0	12		
				Ls - A/A slightly damp at 65 feet
	0	13		
70	0	14		
	0	15		
	2			Ls - A/A
80	2	16		
	1	17		Ls - A/A
90	0	18		
	1	19		
				Ls - 2 feet thick grayish tan internal, from 96 - 98 feet
100	2	20		breaks up to gravel and rock flour, A/A, slightly damp.

BORING ID No. PT-1

SHEET 2 OF 4

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
100	2	20		
				Noticable odor at 102 feet below ground surface (bgs)
	4	21		No PID reading in breathing zone
110	3	22		Ls - A/A, slightly damp, tan to brown, very loose and friable
				from 108 to 110 feet, HC odor below 110 feet
				Ls - becoming cream to buff/tan, more dense, less rock
	48	23		flour mostly gravel size clasts in cuttings below 112
				feet, water at 118 feet, bit sunk to 119 feet - disconnect drill
120	166	24		pipe-water at 114.2 feet at 1010, 114.1 feet at 1040,
				HC odor on probe, argillaceous clay - red to brown
	25	25		Wet from 118 to 121 feet damp to moist from 121 to 122
				damp, 122 to 124 feet medium stiff, now calcareous
130	36	26		Produced another 10 gallons after connection at 130, first few
				feet of samples moist from water in hole and return line -
				samples/ cuttings becoming dry.
	22	27		
140	28	28		Ls - A/A
	23	29		
150	23	30		
				Strong odor in return air at 150 feet bgs.
				Cuttings got wet from water in system lines,
	195	31		some calcareous mud produced when reaming to 160 feet
160	167	32		

BORING ID No. PT-1

SHEET 3 OF 4

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
160	167	32		Let hole stand 3 hours, check for product, water at 131.5
				feet bgs, no product, strong HC odor on probe.
	207	33		
170	104	34		Clear lines catch water in drum, cuttings moist to wet.
175	14	35		Ls - A/A
				TD hole at 175 feet bgs, pull out will ream hole and set
				well next week. Reaming equipment not on site.
				Ream hole to 180-
				POOH - TD = 169
				Set well
				Screen - 169 to 144 feet bgs 4 inch wrapped 20 slot PVC
				Riser - 144 feet bgs to ground surface 4 inch schedule 40 PVC
				Sand - 169 to 127 feet bgs 11 bags 10/20 sand
				Bentonite - 127 to 121 2-5 gallon buckets 3/8 inch pellets
				Cuttings - 121 to 30 feet bgs
				Grout - 30 feet to 1 foot bgs
				Centralizers at 169, 159, 149, 134, 109,
				89, 64, 39, and 14 feet bgs

BORING ID No. PT-1

SHEET 4 OF 4

BORING LOG

WELL NUMBER: PT-2

LOCATION: South of tank 964 Adjacent to well PD-25

SURFACE ELEVATION: 142 ft MSL

DRILLING COMPANY: Hydrologic

DRILLER: Tony Hobson

LOG BY: Pete Dotsey-DSM

OWNER: CORCO

FACILITY: Penuelas

TOTAL DEPTH: 154 ft bgs

PRODUCT LEVEL: 137 ft bgs

WATER LEVEL: 146 ft bgs

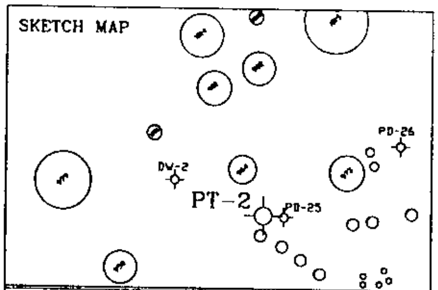
DRILLING METHOD: Dual-Tube Rev. Air

DATE DRILLED: 10/29/95

HELPER: Morris Harrigan

WEATHER: Sunny, Hot 90's Light breeze

SKETCH MAP



NOTES: ± 8 ft. west of PD-25

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
0				Limestone(Ls) - cream to tan, dry, no HC odor
	5	141		dense, large core rock clasts
				Note some clay from bottom of previous hole
	0	142		DW-3 stuck in air return line
10				PID reading may reflect previous hole cuttings
	0	143		
				Clay - red brown, damp, non-calcareous,
				no HC odor from 13 to 15 feet bgs
	0	144		
20				Ls - as above(A/A) below 15 feet bgs
				some thin clay stringers from
	0	145		20 to 29 feet bgs
	0	146		
30				Clay at 29 to 30 and 34 to 39 feet bgs A/A
				Ls - 30 to 34 feet bgs A/A
	0	147		
	0	148		
40				

BORING ID No. PT-2

SHEET 1 OF 4

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
40				Ls – A/A
	0	149		
	0	150		
50				Clay – at 49 to 51 feet bgs A/A
	0	151		Ls – tan to reddish brown, dry, slightly damp, soft
				friable breaking up mostly to rock flour with
	3	152		silt, sand, and gravel fragments,
60				no HC odor, damp to moist at 60 feet
	1	153		Clay – A/A at 60 to 62 feet bgs
				Ls – tan to brown, A/A at 62 to 66 feet bgs
	0	154		
70				Clay – A/A at 66 to 67 feet bgs, damp
				Ls – at 68 to 70 feet bgs, tan to gray,
	8	155		faint HC odor, moist to damp, solid dense
				zone at 72 to 74 feet bgs, friable at 74 to 80 feet
	89	156		bgs, HC odor at 76 to 80 feet bgs, slightly damp
80				
				Ls – tan, soft, mostly friable, damp,
	4	157		HC odor – faint to moderate, some interlayered
				dense Ls zones producing 3 to 4 inch cores
	11	158		
90				
	4	159		
	6	160		
100				

BORING ID No. PT–2

SHEET 2 OF 4

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
100				Ls – A/A, dry to damp, faint HC odor
	4	161		
	21	162		
110				Ls – A/A
	6	163		
	27	164		
120				Ls – A/A
	25	165		Ls – A/A, becoming gray at 126 feet bgs
				gray and tan, damp from 126 to 130 feet bgs
	59	166		
130				Ls – dark gray at 130 to 131 feet bgs, brown and tan
				from 131 to 136 feet bgs, moist to damp,
	62	167		becoming gray at 136 feet bgs, moist to wet,
				strong HC odor at 137 feet bgs, becoming moist to wet,
	319	168		Produce some HC fluids at connection at 140
140				(less than 1 gallon) saturated below 140
				HC film on cuttings
	290	169		Driller notes drill pipe dropping freely at 136 to 140 feet bgs
				collect core sample at 141 feet bgs in HC zone
	129	170		
150				Ls – becoming fairly dense, gray to tan, producing
				clasts/ cores mostly – gray water produce
	55	171		with HC streaks at 150 feet bgs connection
				drill air blowing out of PD 25 (adjacent well)
	56	172		while circulating, collect core sample in water
160				zone at approximately 160 feet bgs

BORING ID No. PT-2

SHEET 3 OF 4

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
160				Reamed to 170 feet bgs
				sluff/cave in to 154 feet bgs
				TD 154 set well
				Screen – 154 to 129 feet bgs 4 inch wrapped 20 slot PVC
				Riser 129 feet bgs to ground surface 4 inch schedule 40 PVC
				Sand – 154 to 150 feet bgs 18 bags 10/20 sand
				Gravel – 150 to 125 feet bgs ± 1 meter ^{3} 1/4 to 1/2 in.
				Cuttings – 125 to 124 feet bgs 3
				Bentonite – 124 to 121.6 feet bgs 1-5 gallon bucket
				3/8 inch pellets
				Cuttings – 124 to 10 feet bgs
				Grout – 10 feet to 1 foot bgs
				Centralizers ss at 154, 139, 114, 89, 64, and 39

BORING ID No. PT-2

SHEET 4 OF 4

BORING LOG

WELL NUMBER: PT-3

LOCATION: North of gate 3 West of yellow foam tank, next to PD-10

SURFACE ELEVATION: 37 ft MSL

DRILLING COMPANY: Hydrologic

DRILLER: Tony Hobson

LOG BY: Pete Dotsey-DSM

OWNER: CORCO

FACILITY: Penuelas

TOTAL DEPTH: 49 ft bgs

PRODUCT LEVEL: 32 ft bgs

WATER LEVEL: 41 ft bgs

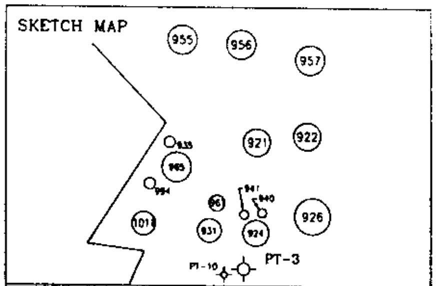
DRILLING METHOD: Dual-Tube Rev. Air

DATE DRILLED: 11/2/95

HELPER: Morris Harrigan

WEATHER: Sunny to ptly. cloudy low 90's light breeze

SKETCH MAP



NOTES: ± 10 ft. East-North East of PD-10

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
0				Limestone(Ls) - tan to cream, dry, faint to
	135	242		moderate HC odor, friable breaking up mostly
				to rock flour with some gravel size core clasts
	78	243		
10				
	111	244		Ls - as above(A/A) slightly more indurated
				producing larger and more gravel size cores
	98	245		
20				
	33	246		Ls - A/A becoming damp at 24 feet
				moist at 30 feet bgs
	63	247		
30				
				Becoming wet with HC at 31 feet bgs
	332	248		becoming tan to brown at 32 feet bgs
				and saturated with HC
	343	249		producing HC fluids at 33 feet bgs
40				calcareous rock flour mud

BORING ID No. PT-3

SHEET 1 OF 2

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
40				Return fluids becoming gray at 44 feet with large
	403	250		core pieces and gray lime mud at 40 feet bgs
				producing gray water at 45 to 50 feet bgs
	104	251		
50				TD well 49 feet
				Screen – 49 to 24 feet bgs 4 inch wrapped 20 slot PVC
				Riser – 24 feet bgs to ground surface 4 inch schedule 40 PVC
				Sand/gravel – 49 to 21 ±10 bags 10/20 sand
				and 1 cft. gravel 1/4 to 1/2 inch
				Bentonite – 21 to 17 1–5 gallon bucket 3/8 inch pellets
				Grout – 17 feet to 1 foot bgs
				Centralizers set at 49, 39, 29 and 19 feet bgs

BORING ID No. PT–3

SHEET 2 OF 2

BORING LOG

WELL NUMBER: PT - 4

LOCATION: South of loading area for tank trucks

SURFACE ELEVATION: 9 ft MSL

DRILLING COMPANY: Hydrologic

DRILLER: Tony Hobson

LOG BY: Pete Dotsey-DSM

OWNER: CORCO

FACILITY: Penuelas

TOTAL DEPTH: 24 ft bgs

PRODUCT LEVEL: 24 ft bgs

WATER LEVEL: 6 ft bgs

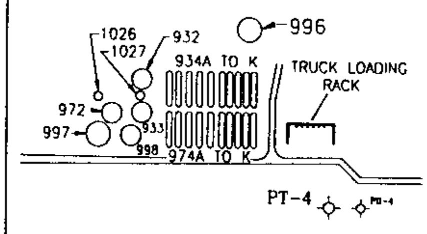
DRILLING METHOD: Dual-Tube Rev. Air

DATE DRILLED: 11/3/95

HELPER: Morris Harrigan

WEATHER: Hot 80's - 90's breezy, partly cloudy to sunny

SKETCH MAP



NOTES:	± 9 feet west of PD-4

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
0				Clay/Weathered Limestone - calcareous, brown,
	78	257		soft to very soft, very moist, becoming gray to
				dark gray at 5 feet, HC odor, circulation air
	51	258		pushing diesel out of PD-4 (4 to 5 oz.'s),
10				back off on pressure contains limestone(Ls) gravel
				throughout very dark gray with diesel odor at 10 feet,
	48	259		check fluid at 10 feet bgs connection -
				4 inch product in well
20				No returns from below 15, calcareous clay
				plugging bit and return line, decide to drill
	31	260		without air to 25 feet
				Collect sample for PID from bottom of bit ±23 to 24 feet
				Attempted installation 3 times, hole closed in,
				reamed with triple wall
				Screen-19 to 4 feet bgs 4 inch wrapped 20 slot PVC
				Riser-4 feet bgs to ground surface 4 inch schedule 40 PVC
				Sand-19 to 3 feet bgs (± sluff from 19 to 10 feet bgs)
				10-80 lb. bags 10/20 sand

BORING ID No. PT-4

SHEET 1 OF 2

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
				Bentonite-3 to 2 feet bgs 3/8 inch pellets ± 4 gallons
				Grout-2 feet to 1 foot bgs
				Reamed hole with triple wall,
				no centralizers used, well set
				inside 8 inch triple wall casing.

BORING ID No. PT-4

SHEET 2 OF 2

BORING LOG

WELL NUMBER: PT-5

LOCATION: 8 - 10 feet east of PD-15

SURFACE ELEVATION: 35 ft MSL

DRILLING COMPANY: Hydrologic

DRILLER: Tony Hobson

LOG BY: Pete Dotsey-DSM

OWNER: CORCO

FACILITY: Penuelas

TOTAL DEPTH: 49 ft bgs

PRODUCT LEVEL: 29 ft bgs

WATER LEVEL: 38 ft bgs

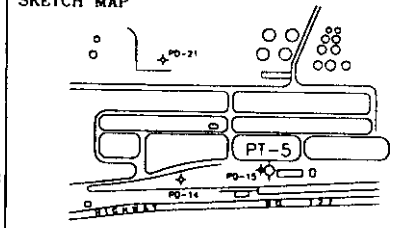
DRILLING METHOD: Dual-Tube Rev. Air

DATE DRILLED: 11/8/95

HELPER: Morris Harrigan

WEATHER: Cloudy, drizzle to moderate rain

SKETCH MAP



NOTES: In front of Warehouse 8 to 10 feet east of PD-15

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
0				Limestone(Ls) - tannish cream to brown,
	17	263		friable, dry, faint HC odor, breaks up
				to silt to gravel size cuttings
	12	264		HC odor becoming faint to moderate
10				
	5	265		Ls - as above (A/A)
				Clay red brown, damp, noncalcareous, medium
	15	266		stiff at 13 to 14 feet bgs, HC odor
20				Ls - A/A, becoming damp at 20 feet
	5	267		Ls - A/A at 22 to 24 feet, 26 to 26.5 feet,
				and at 29 to 29.5 feet bgs
	222	268		Ls - A/A
30				becoming saturated at 25 to 26 feet
				Ls - gray saturated with HC's, very
	436	269		strong odor at 29 feet bgs
				becoming brown at 35 to 30 feet bgs
	602	270		
40				

BORING ID No. PT-5

SHEET 1 OF 2

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
40				Ls/Clay – calcareous mud, brown, wet,
	796	271		very soft, becoming less muddy
				and more granular at 45 feet bgs
	413	272		Sand – gray coarse grain, slightly calcareous,
				wet to very moist from 45 to 50 feet bgs
50				
				Set well
				Screen – 49 to 24 feet bgs 4 inch wrapped PVC
				Riser – 24 feet to ground surface 4 inch schedule 40 PVC
				Sand – 49 to 20 feet bgs 5 80 lb. bags 10/20 sand
				Bentonite – 20 to 16 feet bgs 2/3-5 gallon
				bucket 3/8 inch pellets
				Grout – 16 feet to 1 foot bgs
				Centralizer installed at 35 feet

BORING ID No. PT-5

SHEET 2 OF 2

BORING LOG

WELL NUMBER: DW-1

LOCATION: ± 200 Ft NW of MW-06 MIS AREA

SURFACE ELEVATION: 191 ft MSL

DRILLING COMPANY: Hydrologic

DRILLER: Tony Hobson

LOG BY: Pete Dotsey-DSM

OWNER: CORCO

FACILITY: Penuelas

TOTAL DEPTH: 205 ft bgs

PRODUCT LEVEL: 187 ft bgs

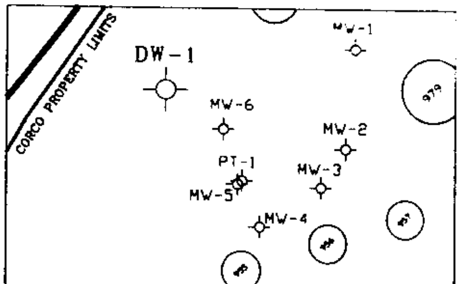
WATER LEVEL: 195 ft bgs

DRILLING METHOD: Dual-Tube Rev. Air

DATE DRILLED: 10/21/95

HELPER: Morris Harrigan

WEATHER: Warm, Breezy, Sunny to cloudy 80's to 90's.



SKETCH MAP

NOTES: ± 200 ft NW at MW06

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
0				Limestone(Ls)-cream to tan, dry friable,
	0	36		grinds to rock flour with silt, sand and gravel
				fragments, no hydrocarbons (HC) odor, fossiliferous
10	0	37		
				Ls - (A/A)
	0	38		
20	0	39		
	0	40		
30	0	41		Ls - (A/A)
				Clay - tan to red brown, damp, soft to medium
	0	42		stiff, non-calcareous, no HC odor
40	0	43		

BORING ID No. DW-1

SHEET 1 OF 5

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
40				Ls - at 40.5 feet
				solid layer at 40.5 6 inch core recovered-
	0	44		tan to cream, dry, friable, grinds to
				rock flour, fossiliferous, no HC odor
50	0	45		
	0	46		
60	0	47		
	0	48		
70	0	49		Ls - A/A
	0	50		
				some cores have vugular porosity
				and are highly fossiliferous
80	0	51		grain supported - packstone/grainstone
				Ls - A/A more dense and less poros in places,
	0	52		more poros zones probably grinding
				up into rock flour
90	0	53		
	0	54		
100	0	55		

BORING ID No. DW-1

SHEET 2 OF 5

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
100				
	0	56		
110	0	57		Ls - A/A
	0	58		
				mostly rock flour 116 to 120 feet bgs
120	0	59		
				Ls - A/A
	0	60		
130	0	61		Ls - A/A
	0	62		
140	11	63		Ls - A/A, low PID values,no HC odor to faint HC odor
	18	64		
150	15	65		Ls - A/A, faint HC odor
	7	66		
160	17	67		Ls - A/A, faint HC odor

BORING ID No. DW-1

SHEET 3 OF 5

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
160				
	14	68		
170	1	69		Ls – A/A, becoming damp at 170 feet bgs,
				tan to dark tan, faint to
				moderate HC odor, becoming
	61	70		moist at 175
				mostly rock flour 176 to 180 feet bgs
180	50	71		No water in hole at 180 feet connection
				noticable HC odor in return air
	121	72		Ls – A/A
190	216	73		strong HC odor at 192 in return air
				cuttings very moist to wet
				strong HC odor
	275	74		
200	178	75		water in hole at 190 and 200 feet bgs connections
205	76	76		Pump 10 gallons of water from hole into 5 gallon drum
				Not making water when drilling from 200 to 205 feet bgs
				TD hole 205 feet bgs
				Screen–205 to 180 feet bgs 2 inch 20 slot PVC
				Riser–180 feet bgs to ground surface 2 inch schedule 40 PVC
				Sand–205 to 113 feet bgs (plus some sluff) ±15 bgs 10/20 sand
				Cuttings–113 to 40 feet bgs

BORING ID No. DW–1

SHEET 4 OF 5

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
				Bentonite - 40 to 34 feet bgs (in clay) 1-5 gallon bucket
				3/8 inch pellets
				Grout - 34 feet bgs to 1 foot bgs
				Note 5 bags sand added through annulas with
				tension placed on riser to keep straight
				13 bags sand total. lodged steel tape in filter pack and
				had to pull pipe out of hole & finish completing well.

BORING ID No. DW-1

SHEET 5 OF 5

BORING LOG

WELL NUMBER: DW-2

LOCATION: West of tank 964, NW of PD-25, N-NE at PD-32

SURFACE ELEVATION: 145 ft MSL

DRILLING COMPANY: Hydrologic

DRILLER: Tony Hobson

LOG BY: Pete Dotsey-DSM

OWNER: CORCO

FACILITY: Penuelas

TOTAL DEPTH: 166 ft bgs

PRODUCT LEVEL: 142 ft bgs

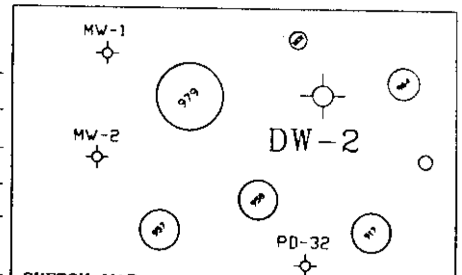
WATER LEVEL: 142.5 ft bgs

DRILLING METHOD: Dual-Tube Rev. Air

DATE DRILLED: 10/23/95

HELPER: Morris Harrigan

WEATHER: Clear to cloudy warm 80's-90's



SKETCH MAP

NOTES: West of Tank 964 NW of PD-25, N-NE of PD-32

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
0				Limestone(Ls)-tan to buff, dry, partly
	0	77		friable to dense gravel to silt
				size clasts, no hydrocarbon (HC) odor
10	0	78		
	0	79		
				Ls - (A/A) becoming damp, more friable
20	0	80		with more rock flour in cuttings
	0	81		Ls - (A/A)
30	0	82		
				Ls - becoming gray with HC odor, damp,
	17	83		
40	33	84		

BORING ID No. DW-2

SHEET 1 OF 4

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
40				
	49	85		Ls – slightly damp to dry, tan to brown, HC odor, cuttings mostly silt
	1	86		(70% rock flour and 30% larger clasts)
50				
	0	87		Ls – cream tan to buff dry, friable with, silt to gravel fragments, fossiliferrous
60	0	88		Ls – (A/A), very faint HC odor
	1	89		
	1	90		
70				Ls – A/A
	0	91		
	9	92		
80				Ls – A/A, HC odor
	5	93		
	4	94		
90				Ls – A/A, HC odor
	11	95		
	9	96		
100				

BORING ID No. DW-2

SHEET 2 OF 4

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
100				Ls - A/A
	25	97		
	16	98		
				Clay - red brown, noncalcareous, with
110	12	99		some shell fragments, soft to medium
				stiff moist at 109 t0 114 feet bgs
	0	100		Ls - gray 0.5 feet at 114 to 114.5
				Clay - A/A, 114.5 to 117 feet bgs
				Ls - A/A, at 117 to 119 feet bgs
120				Clay - A/A, 119 to 127 with interlayered
	45	101		limestone at 125 to 125.5 feet bgs
	46	102		Ls - A/A, more solid/dense, forming
130				solid cores at 128 to 130 feet bgs
				becoming more friable at 130 feet bgs
	15	103		
	268	104		Strong HC odor in return air
140				and in cuttings at 135 feet bgs
	261	105		
	223	106		becoming moist at 148 feet bgs
150				
				becoming very moist to wet at 152 feet bgs
	67	107		but not making any water
	7	108		
160				

BORING ID No. DW-2

SHEET 3 OF 4

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
				Ls - A/A driller circulating bottoms up -
				2 gallons water and lime gravel mud
				Set well
				Bottom sump - 166 to 156 feet bgs 2 inch schedule 40 PVC
				Screen - 156 to 131 feet bgs 2 inch PVC 20 slot
				Riser - 131 feet to ground surface 2 inch schedule 40 PVC
				Sand - 166 to 128 feet bgs 10 bags 10/20 sand
				Bentonite - 128 to 116 feet bgs (set in clay)
				Cuttings - 116 to 22 feet bgs
				Grout - 22 feet to 1 foot bgs
				Centralizers placed at 151, 126, 101
				76, 51, and 26 feet bgs

BORING ID No. DW-2

BORING LOG

WELL NUMBER: DW-3

LOCATION: South of Tank 956 ± 200 to 300 ft.

SURFACE ELEVATION: 136 ft MSL

DRILLING COMPANY: Hydrologic

DRILLER: Tony Hobson

LOG BY: Pete Dotsey-DSM

OWNER: CORCO

FACILITY: Penuelas

TOTAL DEPTH: 155 ft bgs

PRODUCT LEVEL: 132 ft bgs

WATER LEVEL: 141 ft bgs

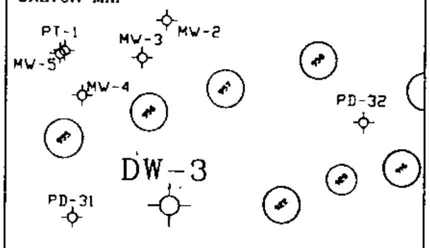
DRILLING METHOD: Dual-Tube Rev. Air

DATE DRILLED: 10/21/95

HELPER: Morris Harrigan

WEATHER: Hot 90's sunny

SKETCH MAP



NOTES: South of Tank 956 between Well PD-31 and PD-32

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
0				Limestone(Ls) - tan to cream, dry, no hydrocarbon (HC) odor,
	0	109		hard layer 0 to 2 feet, more friable from 2 to 8 feet bgs
				hard layer from 8 to 10 feet bgs
	0	110		solid cores return with cuttings
10				
				becoming more soft and friable
	0	111		from 10 to 15 feet bgs
	0	112		Clay - interlayer with limestone from 15 to 21
20				feet bgs, red brown, noncalcareous damp,
				soft to medium stiff, no HC odor
	0	113		
	1	114		
30				
				Ls - (A/A), faint HC odor
	13	115		
	16	116		
40				

BORING ID No. DW-3

SHEET 1 OF 4

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
40				
	0	117		Note delayed grab sampling at 45 and 50 feet
				bgs may have effected PID reading
	3	118		
50				
	17	119		Ls – A/A
	19	120		
60				becoming moist to damp at 60 feet
				tan to light reddish tan
	23	121		
	51	122		becoming moist at 70 feet – soft clay-like
70				consistancy, HC odor, gray brown
				72 to 74 feet, HC odor, moist to wet
	73	123		
	1	124		gray brown 78 to 80 feet bgs, moist to wet
80				
				Ls – A/A very moist to wet, not making water HC odor
	0	125		
				Clay – red brown at 89 to 94 feet soft, noncalacreous
	2	126		moist, driller reams hole from 80 to 90 feet
90				produced quart of water at 90 feet – connection
				made approximately 10 gallons of water
	17	127		Ls – red brown to tan, dry to damp, producing
				some water after connection at 100 feet bgs
	21	128		first few feet of amples is moist to wet
100				from return line, HC odor

BORING ID No. DW-3

SHEET 2 OF 4

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
100				
	14	129		
	15	130		Ls - A/A
110				
	4	131		
	28	132		Ls - A/A
120				
	11	133		Ls - A/A
	106	134		
130				Driller notes drill pipe falling easy, less
	286	135		cuttings produced, very strong HC odors
				518 ppm at cyclone discharge
	282	136		Strong HC odor with return air
140				At 140 ft bgs drilling down
	399	137		produce ±5 gallons black crude product
				oil with gray mud and gravel,
	388	138		saturated with HC's 140 to 150
150				Ls - mostly gray gravel with some gray
	247	139		lime mud - water saturated - gray water
	331	140		
160				Drilled to 160 feet bgs

BORING ID No. DW-3

SHEET 3 OF 4

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
				Set well – sluff in hole to 155 ft bgs
				Screen – 155 to 130 feet bgs 2 inch PVC
				Riser – 130 feet bgs to ground surface 2 inch schedule 40 PVC
				Sand – 160 to 95 feet bgs ± 10 bags 10/20 sand
				Bentonite – 95 to 91 feet bgs (set in clay) 1–5 gallon bucket
				3/8 inch pellets
				Cuttings – 91 to 27 feet bgs
				Grout – 27 feet to 1 foot bgs
				Used tension line to keep well
				straight and in center of hole

BORING ID No. DW–3

SHEET 4 OF 4

BORING LOG

WELL NUMBER: DW-4

LOCATION: NE of Tank 724
SE of Tank 1022

SURFACE ELEVATION: 212 ft MSL

DRILLING COMPANY: Hydrologic

DRILLER: Tony Hobson

LOG BY: Pete Dotsey-DSM

OWNER: CORCO

ADDRESS: Penuelas

TOTAL DEPTH: 230 ft bgs

WATER LEVEL: 206 ft bgs

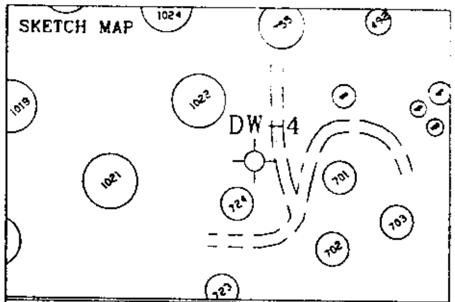
DRILLING METHOD: Dual-Tube Rev. Air

DATE DRILLED: 10/30/95

HELPER: Morris Harrigan

WEATHER: Hot, sunny
80's and 90's

SKETCH MAP



NOTES: NE of Tank 724 and SE of Tank 1022

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
0				Limestone(Ls)-cream to buff, dry, no
	0	173		hydrocarbon (HC) odor, breaking up into
				silt to gravel size clasts, fossiliferous
	0	174		
10				
				becoming more friable from 10 to 18 feet
	56	175		returns mostly silt to sandy, LS with
				pebble size Ls clasts/fragments, slightly
	14	176		damp, slight HC odor at 10 to 20 feet bgs
20				Ls - as above (A/A), no HC odor
	0	177		
	1	178		Clay - red brown, moist at 27.5 to 28 feet
30				Ls - A/A
				Note PID background reading equals 1 ppm
	1	179		
	1	180		
40				Ls - A/A

BORING ID No. DW-4

SHEET 1 OF 5

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
40				Ls - A/A, dry to slightly damp
	0	181		no discernable clay intrval
	1	182		
50				
				Ls - A/A, occasional clay cuttings
	2	183		
	0	184		
				becoming moist to damp at 60 feet
60				tan to light reddish tan
	3	185		
				Clay - red, brown, damp, medium
	108	186		stiff at 66 to 66.5 feet bgs
70				Ls - A/A, HC odor at 65 to 70 feet bgs
				faint HC odor at 70 to 95 feet bgs
	2	187		HC odor at 75 to 80 feet bgs
	64	188		
80				
				Ls - A/A
	2	189		
	1	190		Note - PID zeroing
90				
	1	191		
	1	192		Hard Ls interval at 90 to 99.5 feet well cemented oolitic
100				grainstone with fractures, cream to white, dry

BORING ID No. DW-4

SHEET 2 OF 5

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
100				
	0	193		Clay – A/A, at 99.5 to 100 feet bgs and
				103 to 103.5 feet bgs
	1	194		Ls – A/A
110				
				Clay – at 113 to 115 feet bgs, gray, friable
	1	195		to slightly indurated, very silty
				calcareous, dry to slightly damp
	1	196		Ls – A/A with some thin clay layers, arnaceous
120				
				Ls – A/A, dry, no HC odor, friable
	26	197		Clay – at 124 to 125 feet bgs and 128 to 130 feet bgs
				red brown, slightly damp, light gray in places
	36	198		
130				
	6	199		Clay at 131 to 146 feet bgs red
				brown, no HC odor, slightly
	0	200		damp, contains some calcareous
				concretions, plugging drill bit
140				
	5	201		
				Ls – A/A
	4	202		
150				
	0	203		
	0	204		
160				

BORING ID No. DW–4

SHEET 3 OF 5

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
160				Ls – A/A
	1	205		
	0	206		
170				
	1	207		Ls – tan to cream, no HC odor, wet
				perched water zone at 175 feet bgs –
	0	208		produced ± 5 gallons water, no HC odor
180				
	0	209		
				Clay – at 182 to 184 feet bgs,
	0	210		tan to red brown, calcareous
190				Ls – at 184 becoming damp to dry
	0	211		Clay – A/A, red brown, damp, no HC odor
				at 192 to 192.5 feet bgs
	0	212		Ls – A/A, dry, no HC odor, friable to
200				indurated rock making rock flour and solid cores
	0	213		Clay – at 207 to 210 feet bgs, red brown slightly
				damp, no HC odor, becoming gray at 210 feet bgs
	0	214		
210				
				Ls – at 211 feet bgs A/A, dry, no HC odor,
	0	215		returns rock flour mostly to 212 feet bgs, clay
				at 212 ft to 215 ft becoming mostly
				rock flour at 215 ft and moist at 216–217 ft
220				(Test PID w/ink marker–working fine) damp to dry below 217 ft

BORING ID No. DW–4

SHEET 4 OF 5

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
220				Ls - A/A
	0	217		
	0	218		
230				Ls - A/A mostly rock flower no HC odor
				becoming moist to wet at 232 ft bgs
	1	219		moist to damp 232-242 feet bgs
				becoming tan to brown pull drill pipe/bit back to 220 feet bgs.
	0	220		fluid level following morning at 213 feet bgs. TD 242 feet bgs
240				Set well inside augers-sand bridging in augers. well lifting
				out of hole w/augers. pull pipe & well. bridge at 86 feet bgs
				Ream hole to 232 feet. sluff in hole to 230 feet bgs
				Pull pipe set well TD 230 feet bgs
				Screen - 230 to 205 feet bgs 20 slot PVC
				Riser - 205 to ground surface 2 inch schedule 40 PVC
				Sand - 232 to 201 feet bgs 13 50 lb. bags 20/30 sand
				Bentonite - 201 to 196 feet bgs 1-5 gallon bucket
				3/8 inch pellets
				Cuttings - 196 to 22 feet bgs
				Grout - 22 feet to 1 foot bgs
				Centralizers set at 230, 215, 185
				155, 125, 75, and 65 feet bgs

BORING ID No. DW-4

SHEET 5 OF 5

BORING LOG

WELL NUMBER: DW-5

LOCATION: North of Tank 908 West of Tank 947

SURFACE ELEVATION: 85 ft MSL

DRILLING COMPANY: Hydrologic

DRILLER: Tony Hobson

LOG BY: Pete Dotsey-DSM

OWNER: CORCO

FACILITY: Penuelas

TOTAL DEPTH: 99 Ft bgs

PRODUCT LEVEL: 80 ft bgs

WATER LEVEL: 89 ft bgs

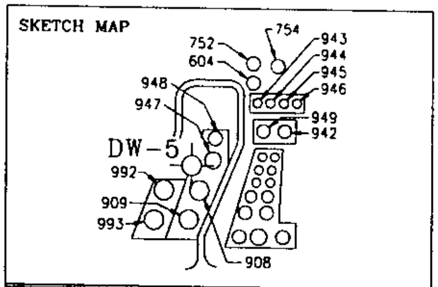
DRILLING METHOD: Dual-Tube Rev. Air

DATE DRILLED: 11/1/95

HELPER: Morris Harrigan

WEATHER: Sunny to cloudy 80's to 90's, calm to light breeze

SKETCH MAP



NOTES: North of Tank 908 and West of Tank 947

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
0				Limestone(Ls)-cream to tan, partly friable,
	0	221		dry, no hydrocarbon (HC) odor, cuttings
				small gravel, core pieces to rock flour
	0	222		
10				Clay - brown to red, slightly damp,
				at 1 to 2 feet bgs, no HC odor
	0	223		Ls - tan, damp, no HC odor,
				dark gray at 13 to 16 feet bgs, light
	0	224		gray to tan at 16 to 20 feet bgs, dry
20				
	0	225		Ls - tan, dry, no HC odor, friable
				gravel size core clasts to fine-grain rock flour
	0	226		
30				
				Faint HC odor at 30 to 35 feet bgs
	1	227		
				Ls - (A/A)
	1	228		
40				

BORING ID No. DW-5

SHEET 1 OF 3

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
40				Ls - A/A, faint HC odor
	8	229		
	13	230		
50				
				Ls - A/A, becoming damp, HC odor, no returns,
	12	231		drill pipe falling easily at 56 to 57 feet bgs
	18	232		
60				Ls - (A-A) becoming moist to damp at 60 feet, HC odor
	67	233		
				Clay - at 69.5 to 70.5 feet bgs
	139	234		red brown moist
70				Ls - tan to light gray, damp
				fine-grain rock flour, HC odor
	134	235		HC odor noticable in return air
	308	236		
80				
				Ls - A/A, becoming moist to wet at 90 feet bgs,
	378	237		saturated with HC below 90 feet bgs,
				strong HC odor, very fine grained rock flour
	300	238		
90				
	326	239		Ls/Clay - at 90 to 94 feet bgs, brown to tan, calcareous
				clay/mud, HC saturated 90 94 feet bgs
	176	240		Ls - light gray to tan becoming mostly tan
100	100	241		below 95 feet, moist to wet, HC odor

BORING ID No. DW-5

SHEET 2 OF 3

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
100				Drill to 99 feet bgs
				Check fluid level in well after 20 minutes
				HC at 84 feet bgs
				Water at 87 feet bgs
110				Decide to set well TD 99 feet bgs
				Screen-99 to 74 feet bgs 2 inch 20 slot PVC
				Riser-74 feet bgs to ground surface 2 inch schedule 40 PVC
				Sand-98 to 70.5 feet bgs 12-50 lb. bags 20/30 sand
				Bentonite-70.5 to 66.6 feet bgs 1-5 gallon bucket
120				3/8 inch pellets
				Cuttings 66.6 to 17 feet bgs
				Grout 17 feet to 1 foot bgs
				Centralizers at 99, 79, 59, and 29, feet bgs

BORING ID No. DW-5

SHEET 3 OF 3

BORING LOG

WELL NUMBER: DW-6

LOCATION: East NE of Tank 980

SURFACE ELEVATION: 15 ft MSL

DRILLING COMPANY: Hydrologic

DRILLER: Tony Hobson

LOG BY: Pete Dotsey-DSM

OWNER: CORCO

FACILITY: Penuelas

TOTAL DEPTH: 19 Ft bgs

PRODUCT LEVEL: 8.5 ft bgs

WATER LEVEL: 9.8 ft bgs

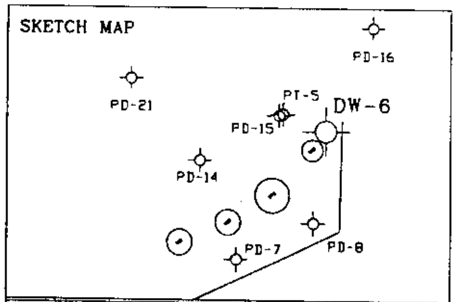
DRILLING METHOD: Dual-Tube Rev. Air

DATE DRILLED: 11/1/95

HELPER: Morris Harrigan

WEATHER: Warm, sunny 90's

SKETCH MAP



NOTES: East-northeast of Tank 980 in tank bermed area.

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
0				
				Clay - calcareous clay, moist, brown (0-1 foot bgs)
	80	252		weathered, moderate hydrocarbon (HC) odor
	44	253		Limestone(Ls) - tan to buff, dry,
	322	254		faint HC odor, medium dense,
10				partly friable, gravel size core cuttings,
				becoming moist to damp
	184	255		
				Ls - wet, HC odor, gravel and lime mud returns
	40	256		check fluid at 20 foot connection -
20				water at 13 feet bgs, no product in hole,
				gravel caving in, ream to 25 feet
				Clay - at 19 to 25 feet bgs
				red brown, damp to moist
				noncalcareous, faint HC odor
30				
40				

BORING ID No. DW-6

SHEET 1 OF 2

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
				Set well to 19 feet TD
				Screen - 19 to 4 feet bgs 2 inch PVC 20 slot
				Riser - 4 to groud surface 2 inch schedule 40 PVC
				Sand - 19 to 3 feet bgs ± 8 - 80 lb. bags 20/30 sand
				Bentonite - 3 to 2 feet bgs 2/3-5 gallon bucket
				3/8 inch pellets
				Grout - 2 feet to 1 foot bgs
				Centralizers - at 19 and 9 feet bgs

BORING ID No. DW-6

SHEET 2 OF 2

BORING LOG

WELL NUMBER: DW-7

LOCATION: North of tank truck fuel loading area

SURFACE ELEVATION: ± 10 ft

DRILLING COMPANY: Hydrologic

DRILLER: Tony Hobson

LOG BY: Pete Dotsey-DSM

OWNER: CORCO

FACILITY: Penuelas

TOTAL DEPTH: 19 ft bgs

PRODUCT LEVEL: 8.5 ft bgs

WATER LEVEL: 9.8 ft bgs

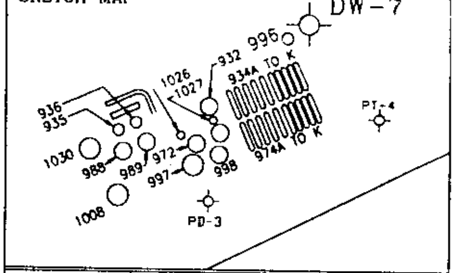
DRILLING METHOD: Dual-Tube Rev. Air

DATE DRILLED: 11/5/95

HELPER: Morris Harrigan

WEATHER: Overcast cloudy high 80's, hard rain at 10 feet

SKETCH MAP



NOTES: North of Tank truck fuel area, East of Tank 996

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
0				Clay - red brown, damp to moist, soft to medium
	81	261		stiff, becoming reddish rust orange at 4 to 5 feet bgs
				Hydrocarbon (HC) odor and mist in return air
	123	262		at 4 to 5 feet, HC odor slightly calcareous
10				Ls-tan, moist to wet, HC odor
				Clay - as above (A/A), gray to red rust
				Hard rain falling - inhibiting PID monitoring
				calcareous, fragments produce with cuttings
				Ls-A/A
20				becoming very wet, producing a little
				water, becoming brown at 23 feet
				Sand - dark gray, wet, fine to coarse
30				with silt and gravel (poorly sorted)
				subrounded to subangular at 25 feet bgs to TD
				Set well - TD 29 feet bgs
				Screen - 29 to 4 feet bgs 2 inch 20 slot PVC
40				Riser - 4 feet bgs to ground surface 2 inch schedule 40 PVC

BORING ID No. DW-7

SHEET 1 OF 2

BORING LOG

DEPTH (FEET)	PID READING	PID LOG NUMBER	SAMPLE	SAMPLE DESCRIPTION
				Sand - 29 to 3 feet bgs 8-80 lb bags 20/30 sand
				Bentonite - 3 to 2 feet bgs 1-5 gallon bucket 3/8 pellets
				Grout - 2 feet to 1 foot bgs
				Centralizers at 29, 19, and 9 feet bgs

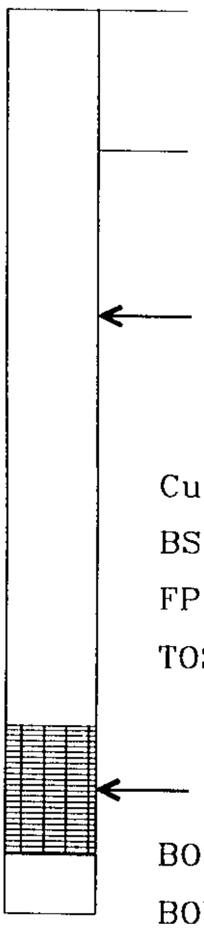
BORING ID No. DW-7

SHEET 2 OF 2

APPENDIX A-2
COMPLETED WELL CONSTRUCTION DIAGRAMS

Well Number DW-1

Construction Diagram



TOC 0.19 feet
X ags
___ bgs

BG 20 to 1 feet bgs

2 inch Schedule 40 PVC

Cuttings 113 to 40 feet and 34 to 20 feet bgs

BS 40 to 34 feet bgs

FP 205 to 113 feet bgs

TOS 180 feet bgs

2 inch 20 slot
___ wrapped PVC
X slotted PVC

BOS 205 feet bgs

BOW 205 feet bgs

TOC–Top of Casing

ags–Above Ground Surface

bgs–Below Ground Surface

egs–Equal to Ground Surface

PVC–Poly Vinyl Chloride

BG–Bentonite Grout

FP–Filter Pack

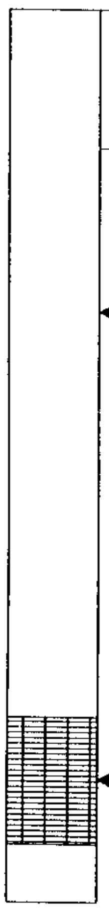
TOS–Top of Screen

BOS–Bottom of Screen

BOW–Bottom of Well

Well Number DW-2

Construction Diagram



TOC 0.00 feet egs

BG 22 to 1 feet bgs

2 inch Schedule 40 PVC

Cuttings 116 to 22 feet

BS 128 to 116 feet bgs

FP 166 to 128 feet bgs

TOS 131 feet bgs

2 inch 20 slot ____ wrapped PVC

X slotted PVC

BOS 156 feet bgs

BOW 166 feet bgs

TOC-Top of Casing

egs-Equal to Ground Surface

bgs-Below Ground Surface

PVC-Poly Vinyl Chloride

BG-Bentonite Grout

FP-Filter Pack

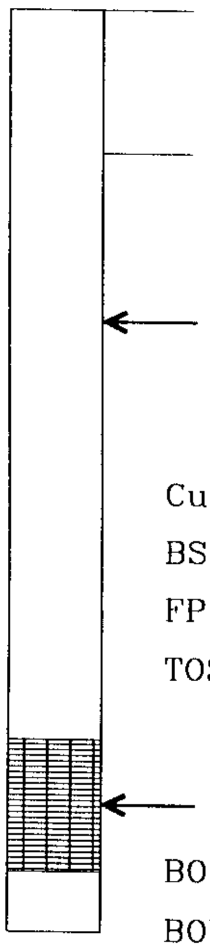
TOS-Top of Screen

BOS-Bottom of Screen

BOW-Bottom of Well

Well Number DW-3

Construction Diagram



TOC 0.00 feet egs

BG 27 to 1 feet bgs

2 inch Schedule 40 PVC

Cuttings 91 to 27 feet

BS 95 to 91 feet bgs

FP 160 to 95 feet bgs

TOS 130 feet bgs

2 inch 20 slot ____ wrapped PVC

X slotted PVC

BOS 155 feet bgs

BOW 155 feet bgs

TOC–Top of Casing

egs–Equal to Ground Surface

bgs–Below Ground Surface

PVC– Poly Vinyl Chloride

BG–Bentonite Grout

FP–Filter Pack

TOS–Top of Screen

BOS–Bottom of Screen

BOW–Bottom of Well

Well Number DW-4

Construction Diagram

TOC 0.25 feet
X ags
___ bgs

BG 22 to 1 feet bgs

2 inch Schedule 40 PVC

Cuttings 196 to 22 feet

BS 201 to 196 feet bgs

FP 232 to 201 feet bgs

TOS 205 feet bgs

2 inch 20 slot
___ wrapped PVC
X slotted PVC

BOS 230 feet bgs

BOW 230 feet bgs

TOC–Top of Casing

ags–Above Ground Surface

bgs–Below Ground Surface

PVC–Poly Vinyl Chloride

BG–Bentonite Grout

FP–Filter Pack

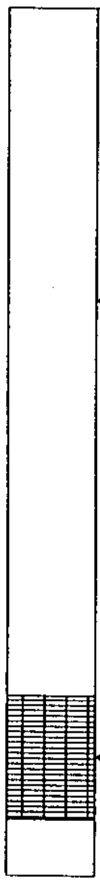
TOS–Top of Screen

BOS–Bottom of Screen

BOW–Bottom of Well

Well Number DW-5

Construction Diagram



TOC 0.35 feet — X ags / ___ bgs

BG 16 to 1 feet bgs

2 inch Schedule 40 PVC

Cuttings 67 to 16 feet

BS 71 to 67 feet bgs

FP 98 to 71 feet bgs

TOS 74 feet bgs

2 inch 20 slot — ___ wrapped PVC / X slotted PVC

BOS 99 feet bgs

BOW 99 feet bgs

TOC–Top of Casing

ags–Above Ground Surface

bgs–Below Ground Surface

PVC–Poly Vinyl Chloride

BG–Bentonite Grout

FP–Filter Pack

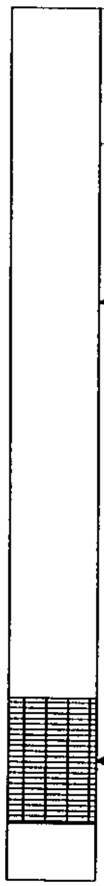
TOS–Top of Screen

BOS–Bottom of Screen

BOW–Bottom of Well

Well Number DW-6

Construction Diagram



TOC 0.26 feet X ags
___ bgs

BG 2 to 1 feet bgs

2 inch Schedule 40 PVC

Cuttings – to – feet

BS 3 to 2 feet bgs

FP 19 to 3 feet bgs

TOS 4 feet bgs

2 inch 20 slot ___ wrapped PVC
X slotted PVC

BOS 19 feet bgs

BOW 19 feet bgs

TOC–Top of Casing

ags–Above Ground Surface

bgs–Below Ground Surface

PVC–Poly Vinyl Chloride

BG–Bentonite Grout

FP–Filter Pack

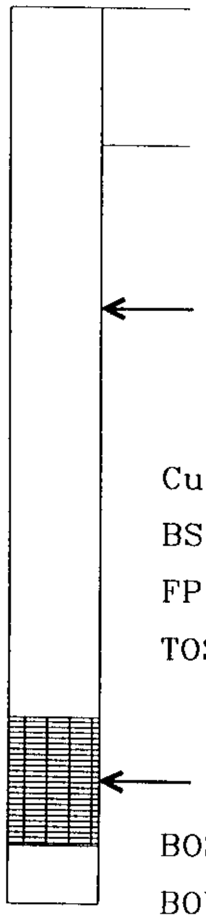
TOS–Top of Screen

BOS–Bottom of Screen

BOW–Bottom of Well

Well Number DW-7

Construction Diagram



TOC 0.15 feet X ags / ___ bgs

BG 2 to 1 feet bgs

2 inch Schedule 40 PVC

Cuttings - to - feet

BS 3 to 2 feet bgs

FP 29 to 3 feet bgs

TOS 4 feet bgs

2 inch 20 slot ___ wrapped PVC / X slotted PVC

BOS 29 feet bgs

BOW 29 feet bgs

TOC–Top of Casing

ags–Above Ground Surface

bgs–Below Ground Surface

PVC–Poly Vinyl Chloride

BG–Bentonite Grout

FP–Filter Pack

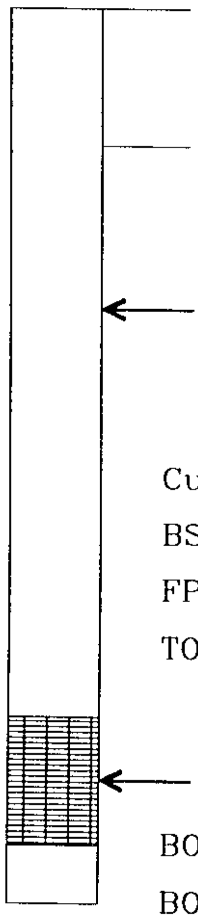
TOS–Top of Screen

BOS–Bottom of Screen

BOW–Bottom of Well

Well Number PT-1

Construction Diagram



TOC 0.10 feet X ags / ___ bgs

BG 30 to 1 feet bgs

4 inch Schedule 40 PVC

Cuttings 121 to 30 feet

BS 127 to 121 feet bgs

FP 169 to 127 feet bgs

TOS 144 feet bgs

4 inch 20 slot X wrapped PVC / ___ slotted PVC

BOS 169 feet bgs

BOW 169 feet bgs

TOC–Top of Casing

ags–Above Ground Surface

bgs–Below Ground Surface

PVC–Poly Vinyl Chloride

BG–Bentonite Grout

FP–Filter Pack

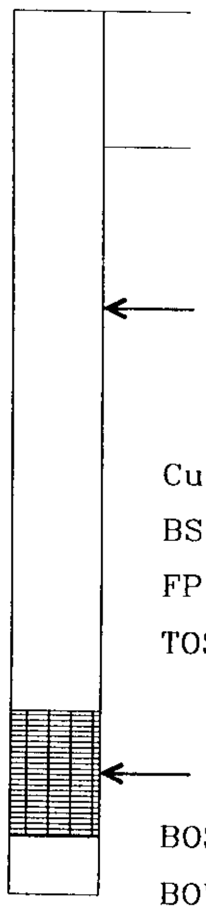
TOS–Top of Screen

BOS–Bottom of Screen

BOW–Bottom of Well

Well Number PT-2

Construction Diagram



TOC 0.15 feet   X ags
___ bgs

BG 10 to 1 feet bgs

4 inch Schedule 40 PVC

Cuttings 125 to 124 feet and 121 to 10 feet bgs

BS 124 to 121 feet bgs

FP 154 to 125 feet bgs

TOS 129 feet bgs

4 inch 20 slot   X wrapped PVC
___ slotted PVC

BOS 154 feet bgs

BOW 154 feet bgs

TOC–Top of Casing

ags–Above Ground Surface

bgs–Below Ground Surface

PVC–Poly Vinyl Chloride

BG–Bentonite Grout

FP–Filter Pack

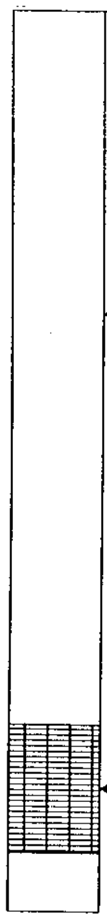
TOS–Top of Screen

BOS–Bottom of Screen

BOW–Bottom of Well

Well Number PT-3

Construction Diagram



TOC 0.31 feet X ags / ___ bgs

BG 12 to 1 feet bgs

4 inch Schedule 40 PVC

Cuttings - to - feet and - to - feet bgs

BS 21 to 17 feet bgs

FP 49 to 21 feet bgs

TOS 24 feet bgs

4 inch 20 slot X wrapped PVC / ___ slotted PVC

BOS 49 feet bgs

BOW 49 feet bgs

TOC-Top of Casing

ags-Above Ground Surface

bgs-Below Ground Surface

PVC-Poly Vinyl Chloride

BG-Bentonite Grout

FP-Filter Pack

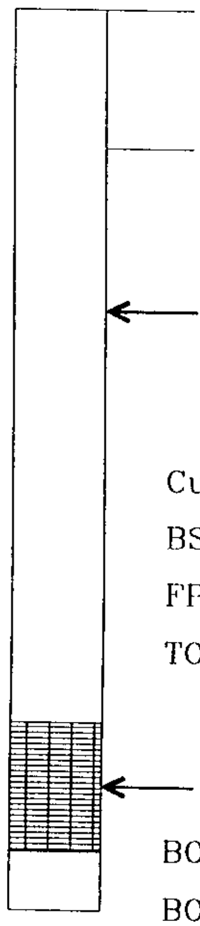
TOS-Top of Screen

BOS-Bottom of Screen

BOW-Bottom of Well

Well Number PT-4

Construction Diagram



TOC 0.23 feet X ags
___ bgs

BG 2 to 1 feet bgs

4 inch Schedule 40 PVC

Cuttings - to -

BS 3 to 2 feet bgs

FP 19 to 3 feet bgs

TOS 4 feet bgs

4 inch 20 slot X wrapped PVC
___ slotted PVC

BOS 19 feet bgs

BOW 19 feet bgs

TOC-Top of Casing

ags-Above Ground Surface

bgs-Below Ground Surface

PVC-Poly Vinyl Chloride

BG-Bentonite Grout

FP-Filter Pack

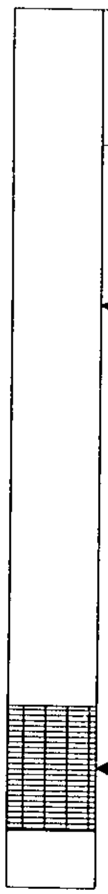
TOS-Top of Screen

BOS-Bottom of Screen

BOW-Bottom of Well

Well Number PT-5

Construction Diagram



TOC 0.02 feet — X ags / ___ bgs

BG 16 to 1 feet bgs

4 inch Schedule 40 PVC

Cuttings - to -

BS 20 to 16 feet bgs

FP 49 to 20 feet bgs

TOS 24 feet bgs

4 inch 20 slot — X wrapped PVC / ___ slotted PVC

BOS 49 feet bgs

BOW 49 feet bgs

TOC–Top of Casing

ags–Above Ground Surface

bgs–Below Ground Surface

PVC–Poly Vinyl Chloride

BG–Bentonite Grout

FP–Filter Pack

TOS–Top of Screen

BOS–Bottom of Screen

BOW–Bottom of Well

EL NUEVO DIA-MARTES 14 DE NOVIEMBRE DE 1995

COORDINADOR/EDUARDO CIFUENTES

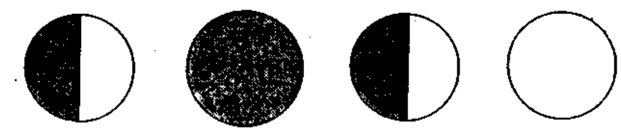
el caribe

Ciudad	Máx	Mín	Pronóstico
Caracas	88	64	pn
La Habana	86	68	pn
St. Thomas	89	71	pn
San Juan	88	73	pn
Santo Domingo	88	70	pn

embalses

	Carraizo	La Plata	Toa Vaca
	41.01m	**50.08m**	**147.67m**
Optimo	41.00m	52.00m	156.00m
Crítico	31.50m	25.00m	123.00m

fases de la luna



Menguante 15 de Noviembre · Nueva 22 de Noviembre · Creciente 29 de Noviembre · Llena 6 de Diciembre

mareas

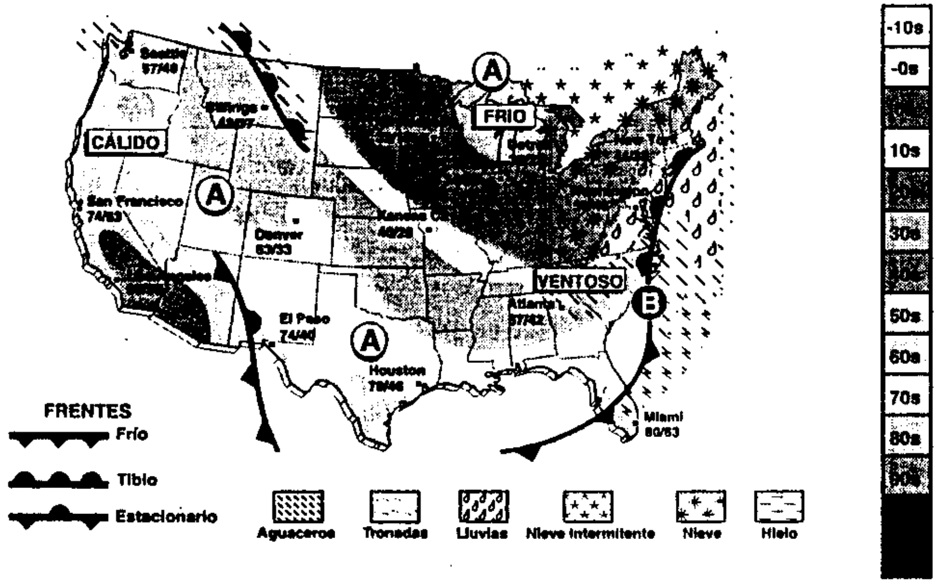
am

Alta: .... 1:03.................... 1.1'
Baja: .... 6:49.................... 0.5'

pm

Alta: .... 1:55.................... 1.7'
Baja: .... 8:45.................... 0.7'

estados unidos



Lo mostrado son posiciones pronosticadas al medio día de sistemas de clima y sistemas de precipitación pluvial. Las líneas indican la temperatura máxima del día. Pronóstico individual de máxima y mínima temperatura son dadas a ciudades seleccionadas.

temperaturas

Ciudad	Hoy Máx	Hoy Mín	Hoy T	Mañana Máx	Mañana Mín	Mañana T
Atlanta	57	42	pn	48	28	a
Boston	42	32	pn	44	40	ll
Chicago	34	20	nu	36	22	pn
Dallas	68	43	s	63	44	s
Denver	53	33	pn	63	35	s
Filadelfia	42	38	nu	48	46	ll
Hartford	40	30	nu	40	38	ll
Houston	78	46	s	68	44	s
Honolulú	82	68	nu	84	71	pn
Los Angeles	88	50	pn	80	56	s
Miami	80	63	pn	78	54	pn
Nueva Orleans	68	41	pn	62	41	s
Nueva York	44	38	nu	46	44	ll
Orlando	74	56	s	68	43	t
San Francisco	74	53	s	70	52	s
Seattle	57	48	a	59	48	nu
Syracuse	34	30	ni	36	32	nv
Washington D.C.	50	40	ll	48	42	ll
Montreal	30	29	nu	37	29	ni
Toronto	34	32	nu	34	30	ni

Ciudad	Hoy Máx	Hoy Mín	Hoy T	Mañana Máx	Mañana Mín	Mañana T
México D.F.	73	50	pn	77	54	pn
Bogotá	64	50	t	66	52	a
Buenos Aires	77	55	s	77	59	pn
La Paz	68	45	pn	68	47	pn
Lima	70	63	pn	70	64	pn
Montevideo	79	56	s	73	59	pn
Río de Janeiro	77	70	ll	84	73	t
Santiago de Chile	72	46	pn	72	46	s
Atenas	63	55	ll	64	53	ll
Berlín	50	32	s	43	34	nu
Londres	51	43	ll	54	46	ll
Madrid	53	42	ll	63	50	a
Moscú	30	26	nu	30	23	pn
París	50	40	ll	54	45	a
Roma	56	47	ll	59	50	a
Beijing	53	34	s	61	48	s
Hong Kong	75	68	pn	75	67	ll
Jerusalén	40	34	nu	45	43	ll
Tokio	66	40	s	64	45	nu
El Cairo	71	54	pn	75	56	pn

Pronóstico: s-soleado, pn-parcialmente nublado, nu-nublado, a-aguaceros, t-tormentas, ll-lluvias, ni-nieve intermitente, nv-nieve, hi-hielo.

APPENDIX C-1
INSTRUCTIONS FOR COMPLETING FLUID FLOW FORMS

GROUNDWATER FLOW METER
KVA FIELD CALCULATION PROCEDURES

1. Set probe/packer assembly to desired depth and orientation (either north or south).
2. Allow well to equilibrate from disturbance of inserting probe.
3. Take background or start reading.
4. Induce heat pulse and record reading at standard lag time (approximately 2 minutes and 30 seconds) after pulse.
5. Subtract start reading from heat pulse reading to get adjusted or actual reading.
6. Repeat procedures 1 through 5 at same depth with reverse orientation (allow 15 minutes for heat decay within probe unit from previous reading).
7. Subtract south actual reading from north actual reading and divide by 2.
8. Scale vector compass based on readings and plot readings.
9. Add vectors segments head to tail.
10. Draw line from origin through endpoint on additive vector segments. This gives you the apparent linear flow direction (which may be adjusted to geographic north).
11. Take half the value of the endpoint of the additive vector segments and divide this value by the calibrated instrument value (obtained from a flow chamber packed with similar material as the formation) in the same range. Note that a calibrated machine value of approximately 33 should be used for the 0 to 3 foot per day range based on flow calibration data for the 20 circumslot ™ screen used in site piezometer wells, since it best reflects the curvi-linear relationship between flow and instrument reading over this range (Dr. William Kerfoot, personal communication).
12. Record the vector direction and derived velocity value on the field worksheet.

APPENDIX C-2
COMPLETED IN-SITU FLUID FLOW FIELD FORMS

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PO-DSM\WK-KVA	Date: 9/12/95
Station: PD-4	Time: N = 1018 S = 0945
Location: CORCO	
Soil Conditions: Weathered Limestone	
Depth to Measurement: 10.5 ft BTOC	

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	8	2	-6
+2/-7	23	37	14
+3/-8	-5	-38	-33
+4/-9	10	0	-10

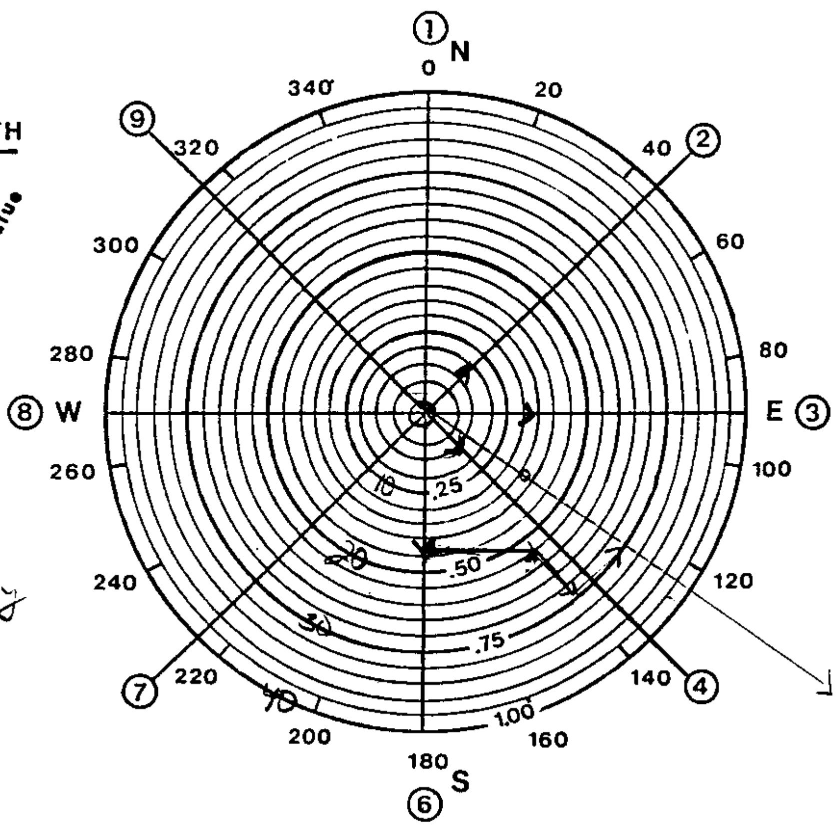
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F / max. value
+1/-6	4	33	29	-175	
+2/-7	11	9	-2	8	
+3/-8	-5	-65	-60	135	
+4/-9	2	-21	-23	65	

$\frac{15}{33}$ 0.45ft/day

I 126°

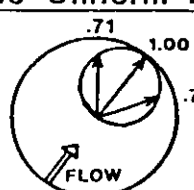


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59•HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 126°	Velocity: 0.45 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PD-DSM\WK-KVA Date: 9/12/95
Station: PD-4 Time: N=0753 S=0813
Location: CORCO
Soil Conditions: Weathered Limestone
Depth to Measurement: 20.5 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	5	32	27
+2/-7	16	-9	-25
+3/-8	2	-135	-137
+4/-9	4	-83	-87

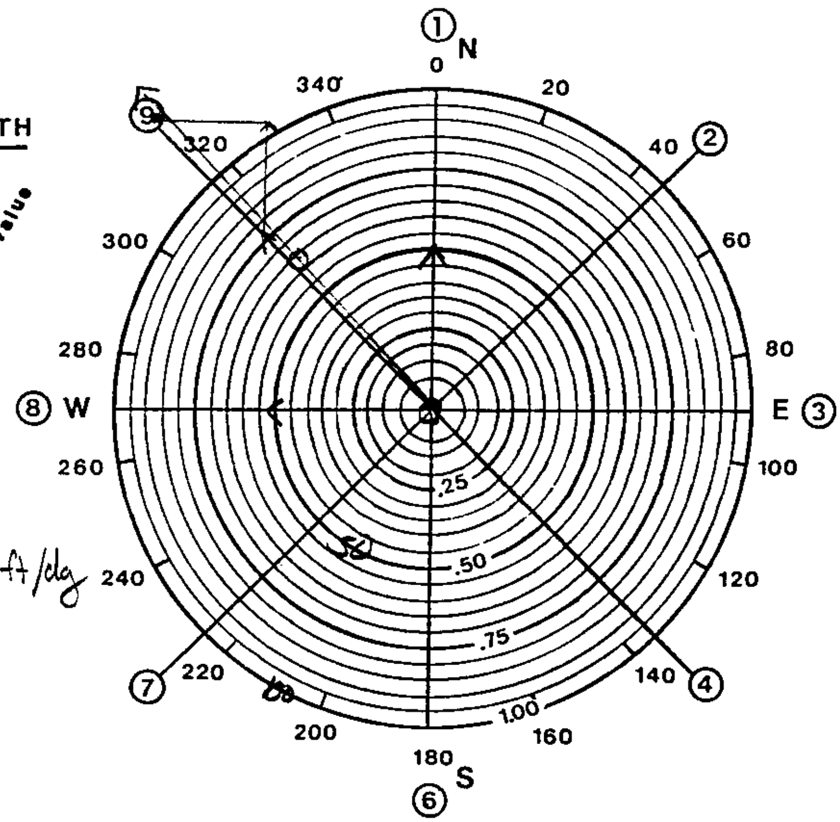
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{max. value}$
+1/-6	6	-71	-77	52	
+2/-7	12	-20	-32	3.5	
+3/-8	0	-33	-33	-52	
+4/-9	0	66	66	-76.5	

$\frac{62.5}{33}$ = 1.89 ft/day

± 317°

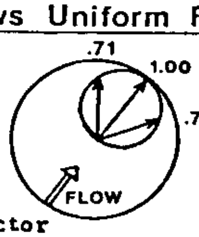


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 317° Velocity: 1.89 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PD-DSM/WK-KVA Date: 9/12/95

Station: PD-4 Time: N= 1003 S= 0925

Location: CORCO

Soil Conditions: Weathered Limestone

Depth to Measurement: 10.5 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	8	0	8
+2/-7	19	29	10
+3/-8	0	-43	-43
+4/-9	3	-4	-7

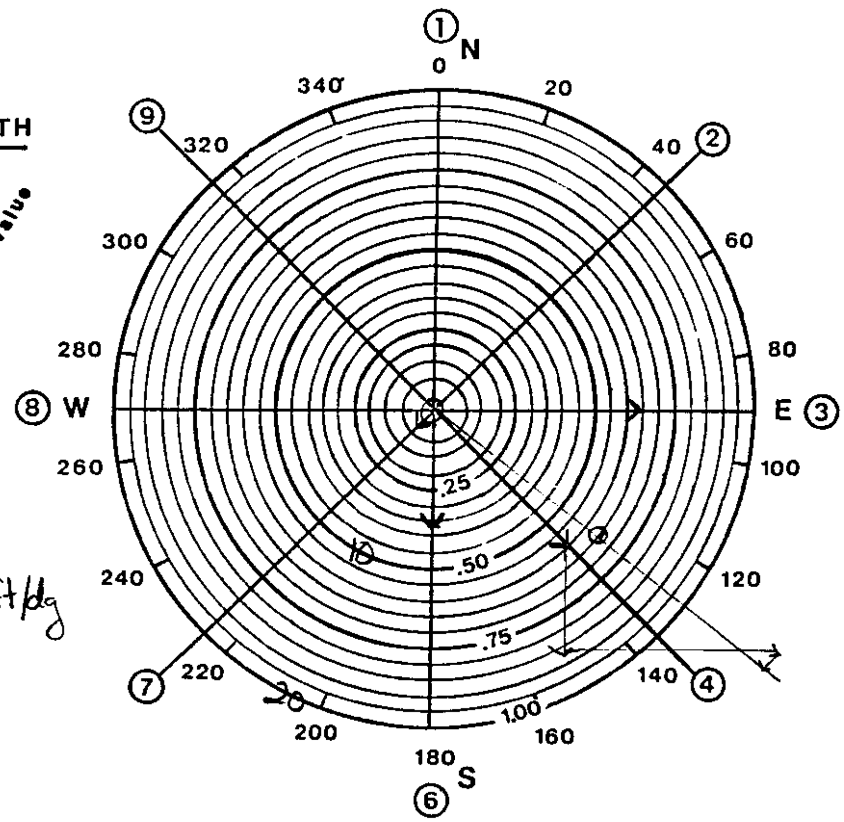
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{max.\ value}$
+1/-6	8	31	23	-7.5	
+2/-7	19	6	13	-1.5	
+3/-8	2	-66	-68	12.5	
+4/-9	2	-29	-31	12	

$\frac{13.2}{33}$ = 0.40 ft/day

± 131°

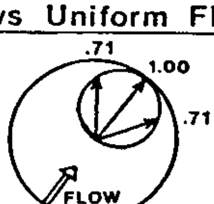


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 131° Velocity: 0.40 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	10	43	33
+2/-7	15	0	-15
+3/-8	-11	-143	-132
+4/-9	-4	-91	-87

Operator: PD-DSM\WK-KVA Date: 9/12/95

Station: PD-4 Time: S=0830 N=0903

Location: CORCO

Soil Conditions: Weathered Limestone

Depth to Measurement: 20.5 ft BTOC

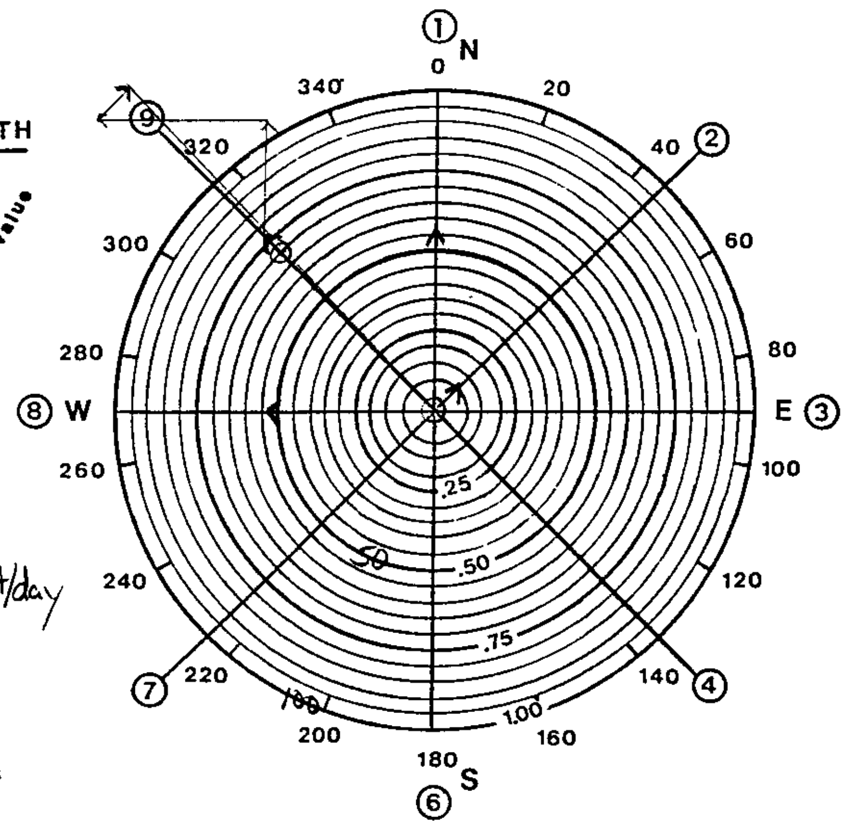
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{max.\ value}$
+1/-6	0	-80	-80	56.5	
+2/-7	18	-19	-37	11	
+3/-8	-3	-29	-26	-53	
+4/-9	16	+81	65	-76	

$\frac{70}{33}$ = 2.12 ft/day

± 316°

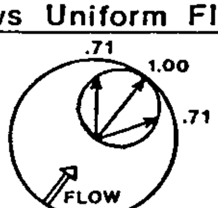


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 316° Velocity: 2.12 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PD-DGM\ WK - KVA Date: 9/11/95

Station: PD-5 Time: N 1120 S 1026

Location: CORCO

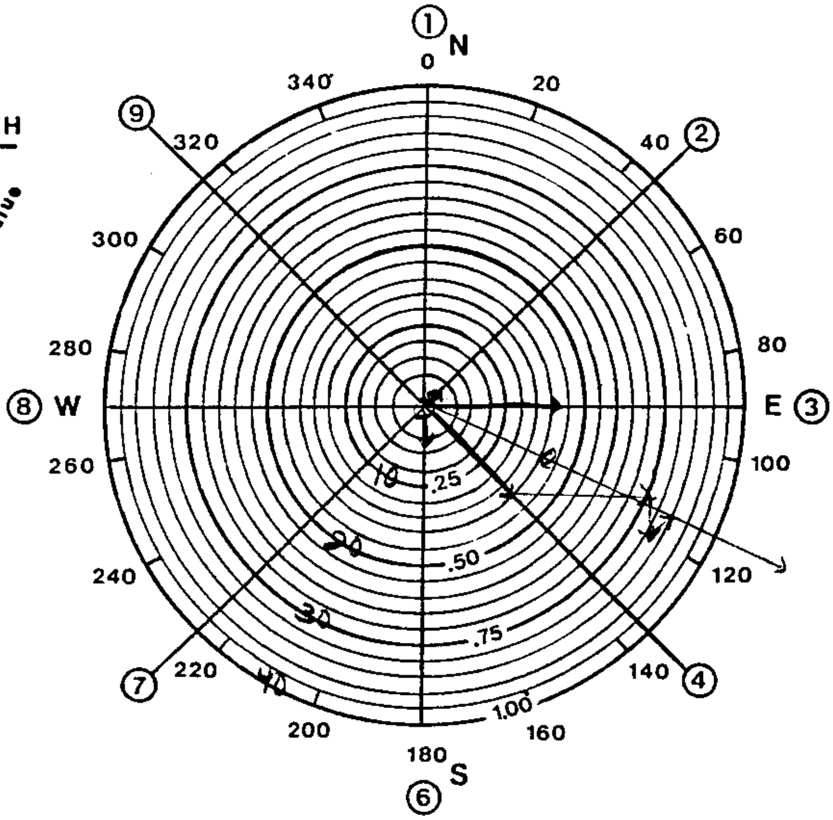
Soil Conditions: Weathered Limestone

Depth to Measurement: 20 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	18	25	7
+2/-7	19	5	-14
+3/-8	-9	-72	-63
+4/-9	-8	-41	-33



ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{\text{max. value}}$
+1/-6	12	29	17	-5	
+2/-7	22	3	-19	2.5	
+3/-8	0	-96	-96	16.5	
+4/-9	0	-65	-65	16	

$\frac{17}{33}$ = 0.52 ft/day

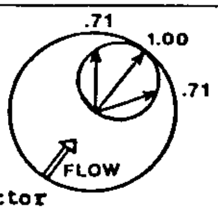
I 115°

Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 115° Velocity: 0.52 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PD-DSM/WK-KVA Date: 9/11/95

Station: PO-5 Time: N = 1050, S = 1026

Location: CORCO

Soil Conditions: Weathered Limestone

Depth to Measurement: 20 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	15	37	+22
+2/-7	19	15	-4
+3/-8	-4	-70	-66
+4/-9	-6	-56	30

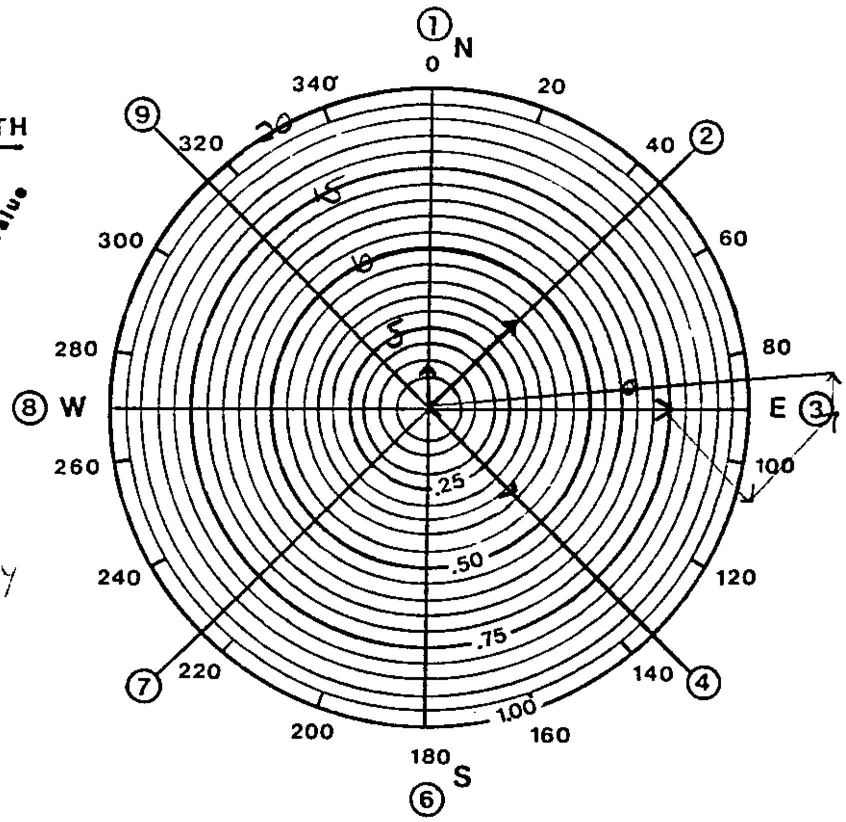
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{max. value}$
+1/-6	12	29	17	2.5	
+2/-7	22	3	-19	7.5	
+3/-8	0	-96	-96	15	
+4/-9	0	-65	-65	7.5	

$\frac{12.5}{33}$ = 0.38 ft/day

≠ 85°

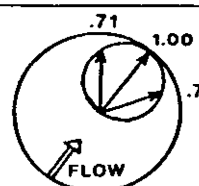


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 85° Velocity: 0.38 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PO-DSM\ WK-KVA Date: 9/11/95

Station: PD-3 Time: N=1527 S=1620

Location: CORCO

Soil Conditions: Weathered Limestone

Depth to Measurement: 20 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	7	43	36
+2/-7	11	63	52
+3/-8	-11	0	11
+4/-9	-5	2	7

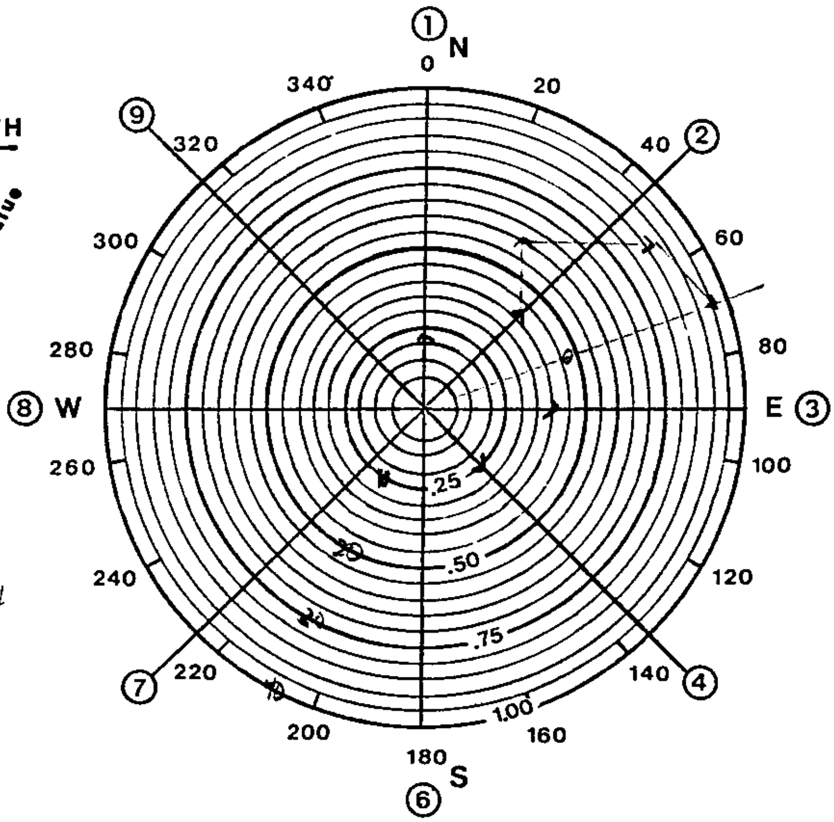
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F/max. value
+1/-6	11	29	18	9	
+2/-7	19	37	18	17	
+3/-8	-5	-27	-22	16.5	
+4/-9	0	-44	-44	10.5	

$\frac{17.5}{33} = 0.53$ ft/day

≅ 70°

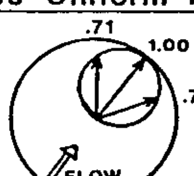


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59+HP41C)calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 70° Velocity: 0.53 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	8	29	21
+2/-7	17	30	13
+3/-8	0	-31	-31
+4/-9	1	-15	-16

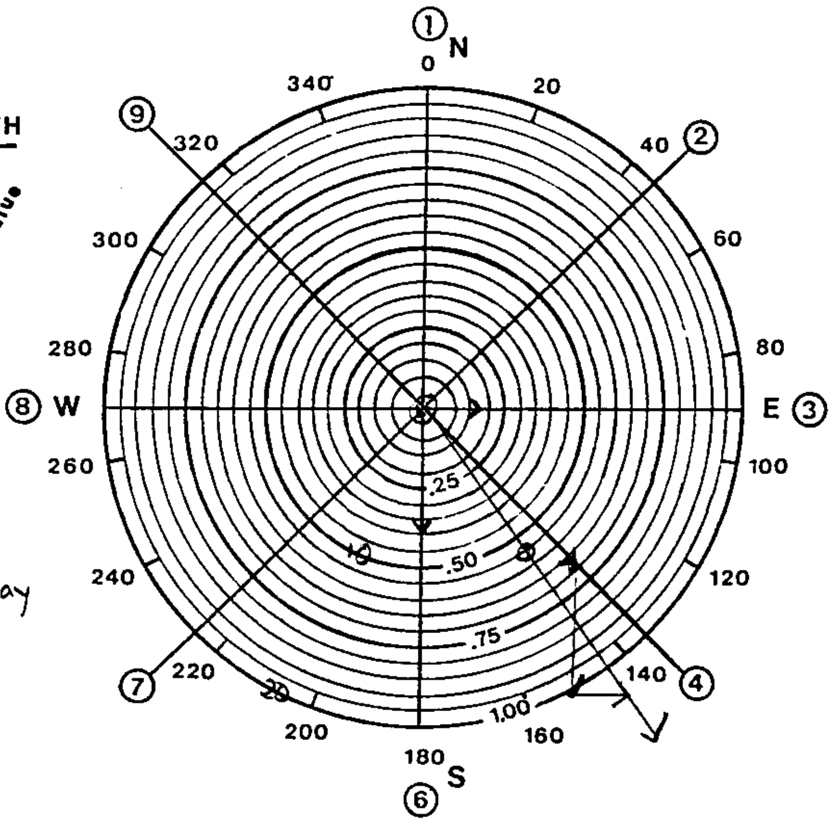
Operator: PO-DSM/UK-KVA Date: 9/11/95

Station: PO-3 Time: N= 1755 S= 1710

Location: CORCO

Soil Conditions: Weathered Limestone

Depth to Measurement: 10 ft BTOC



ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F/max. value
+1/-6	4	41	37	-8	
+2/-7	14	28	14	-0.5	
+3/-8	1	-37	-38	3.5	
+4/-9	4	-39	-43	13.5	

$\frac{11}{33}$ = 0.33 ft/day

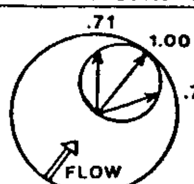
± 143°

Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 143° Velocity: 0.33 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	10	30	20
+2/-7	19	32	13
+3/-8	-4	-31	-27
+4/-9	0	-16	-16

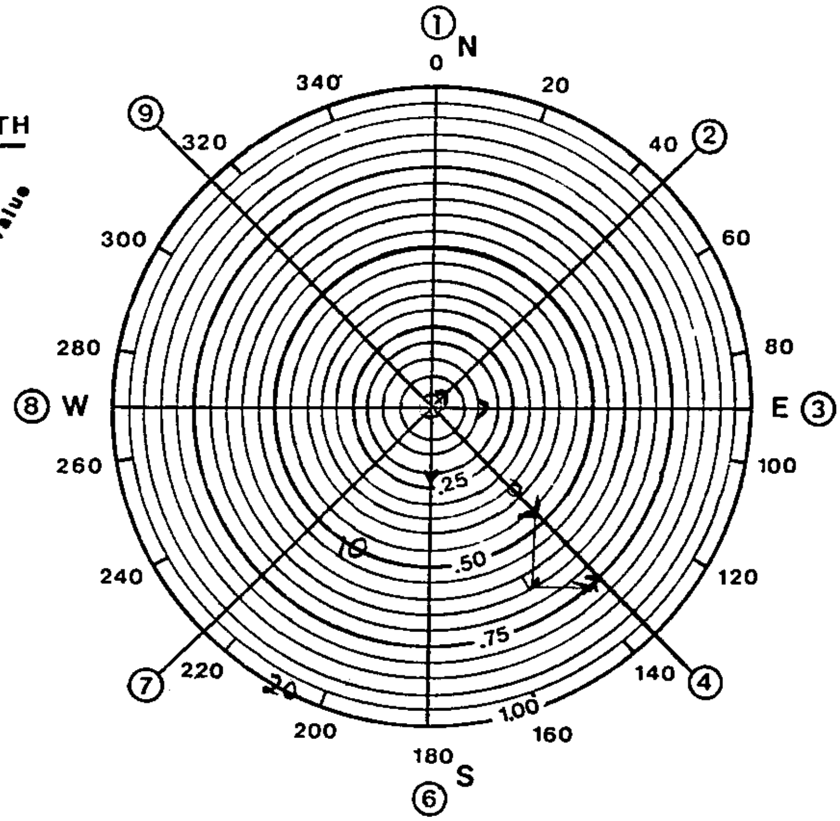
Operator: PD-DEM\WK-KVA Date: 9/11/95

Station: PD-3 Time: N = 1810 S = 1730

Location: CORCO

Soil Conditions: Weathered Limestone

Depth to Measurement: 10 ft BTOC



ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{max.\ value}$
+1/-6	17	46	29	-4.5	
+2/-7	21	31	10	1.5	
+3/-8	-4	-38	-34	3.5	
+4/-9	-9	-44	-35	9.5	

$\frac{7.5}{33}$ = 0.23 ft/day

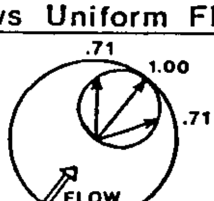
± 135°

Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 135° Velocity: 0.23 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

 9/82

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PD-DSM|WK-KVA   Date: 9/11/95

Station: PD-3   Time: N=1522 S=1614

Location: CORCO

Soil Conditions: Weathered Limestone

Depth to Measurement: 20 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	7	43	36
+2/-7	16	40	24
+3/-8	0	-35	-35
+4/-9	2	-27	-29

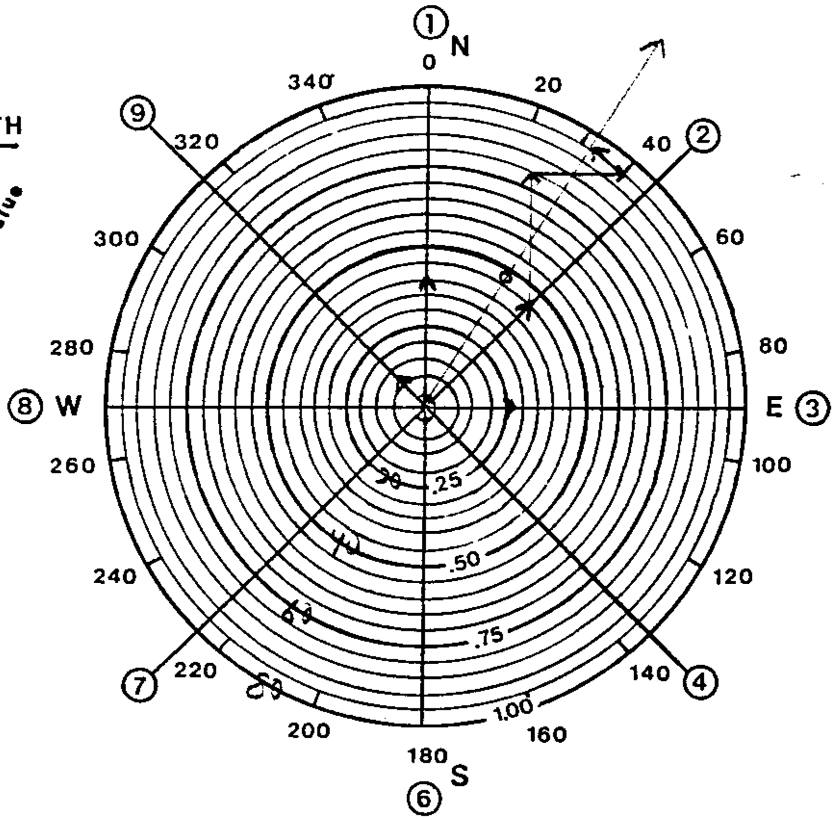
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F/max. value
+1/-6	6	-23	-29	32.5	
+2/-7	15	-34	-49	36.5	
+3/-8	0	-79	-79	22	
+4/-9	2	-8	-10	-9.5	

$\frac{38.5}{33}$ = 1.17 ft/day

± 32°

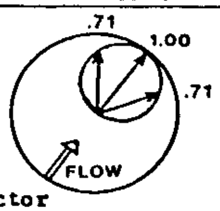


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 32°   Velocity: 1.17 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	12	50	38
+2/-7	22	37	15
+3/-8	1	-69	-70
+4/-9	1	-72	-73

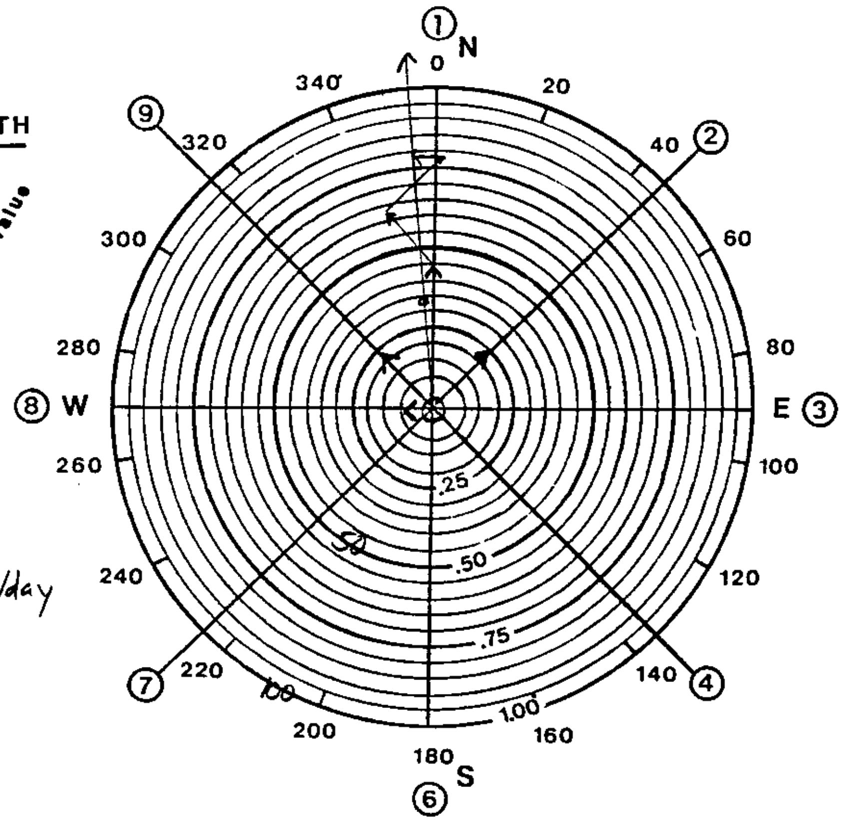
Operator: PD-DSM\WK-KVA Date: 9/14/95

Station: PD-9 Time: S = 1530 N = 1550

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 57.5 ft BTOC



ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F / max. value
+1/-6	7	-44	-51	44.5	
+2/-7	17	-17	-34	24.5	
+3/-8	0	-54	-54	8	
+4/-9	3	-27	-30	-21.5	

$\frac{39}{33}$ = 1.18 ft/day

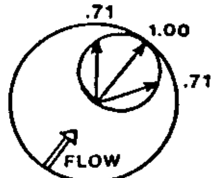
± 354°

Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 354° Velocity: 1.18 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	8	32	24
+2/-7	17	16	-1
+3/-8	-3	-86	-83
+4/-9	3	-53	-56

Operator: PD-OSM\WK-KVA Date: 9/14/95

Station: PD-9 Time: N=1450 S=1510

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 71 ft BTOC

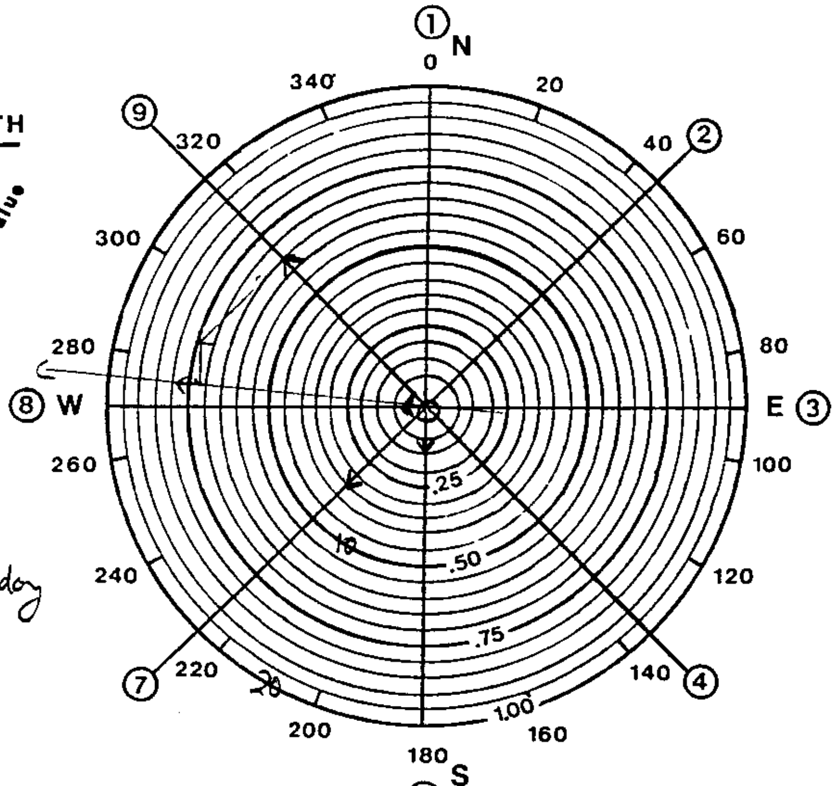
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{\text{max. value}}$
+1/-6	6	36	30	-3	
+2/-7	17	30	13	-7	
+3/-8	0	-80	-80	-1.5	
+4/-9	4	-79	-83	-13.5	

$\frac{7.75}{33}$ = 0.23 ft/day

I 276°

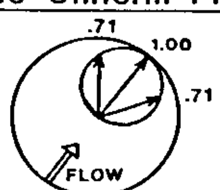


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 276° Velocity: 0.23 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	7	-11	-18
+2/-7	16	67	51
+3/-8	1	33	32
+4/-9	2	45	43

Operator: PD-DSM\WK-KVA Date: 9/12/95

Station: PD-10 Time: S=1315 N=1343

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 40 ft BTOC

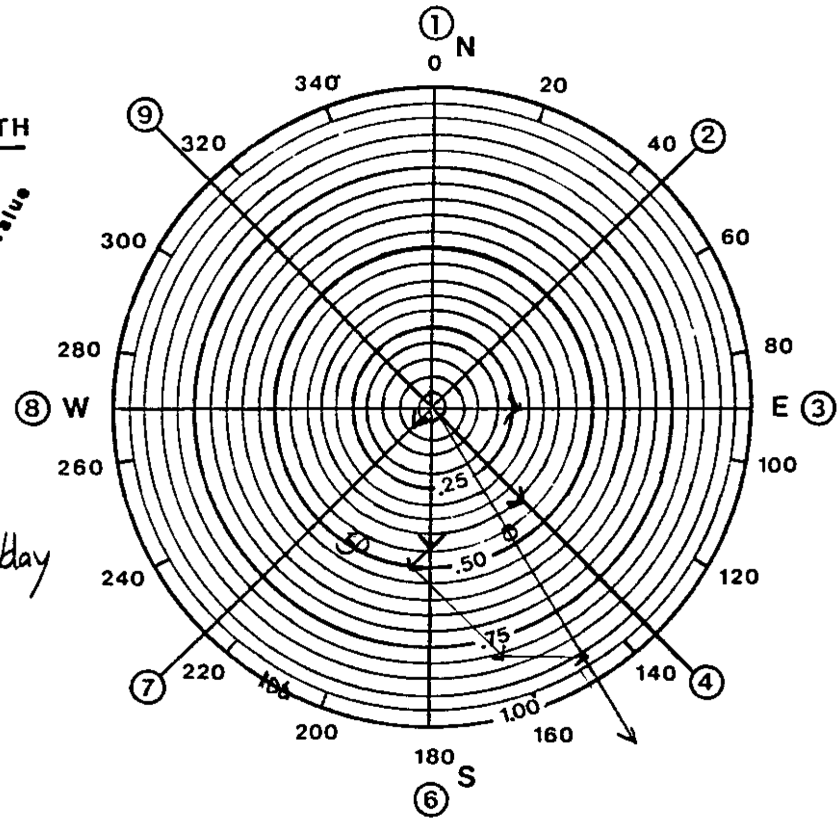
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F / max. value
+1/-6	7	78	71	-44.5	
+2/-7	17	82	65	-7	
+3/-8	0	-21	-21	26.5	
+4/-9	3	-36	-39	41	

$\frac{46}{33}$ = 1.39 ft/day

148°

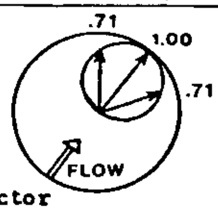


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 148° Velocity: 1.39 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	7	-19	-26
+2/-7	24	58	34
+3/-8	0	12	12
+4/-9	8	41	33

Operator: PD-DSM\WK-KVA Date: 9/12/95

Station: PO-10 Time: N=1358 S=1440

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 40 ft BTOC

ROTATE PROBE 180° AT SAME DEPTH

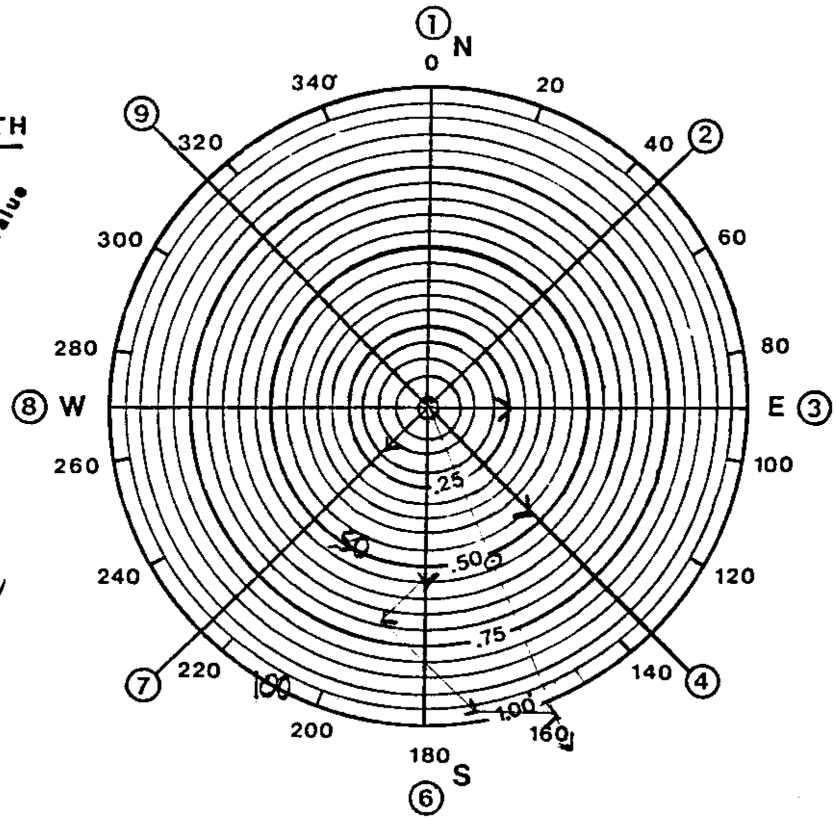
1→S

Probe pair	D start	E end	S E-D
+1/-6	13	100	87
+2/-7	21	89	68
+3/-8	-11	-49	-38
+4/-9	1	-58	-57

F $\frac{N-S}{2}$	G $\frac{F}{max.\ value}$
-56.5	
-17	
25	
46	

$\frac{53}{33}$ = 1.61 ft/day

± 157°

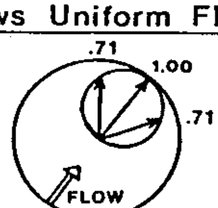


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 157° Velocity: 1.61 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	9	11	2
+2/-7	22	42	20
+3/-8	7	-36	-43
+4/-9	5	23	18

Operator: PD-DSM\WK-KVA Date: 9/12/95

Station: PD-15 Time: N = 1545 S = 1627

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 32.5 ft BTOC

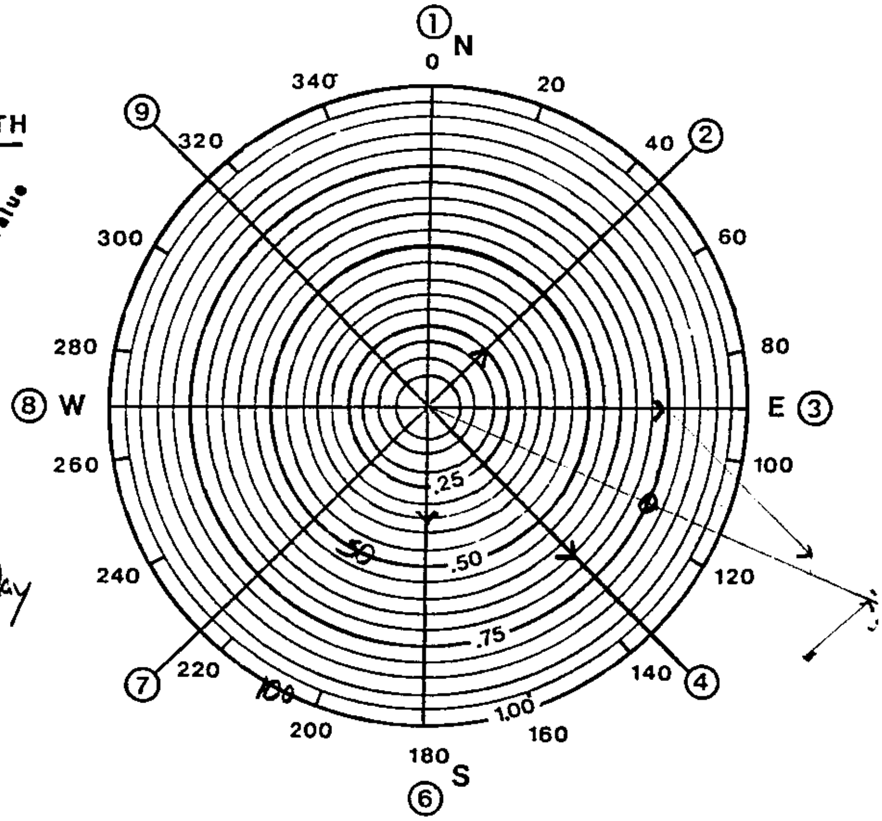
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F / max. value
+1/-6	8	82	74	-36	
+2/-7	15	-15	-30	25	
+3/-8	-10	-202	-192	74.5	
+4/-9	0	-106	-106	62	

$\frac{75}{33} = 2.27$ ft/day

≈ 114°

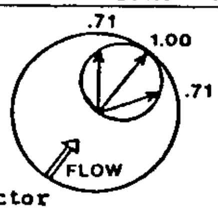


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 114° Velocity: 2.27 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	8	2	-6
+2/-7	21	41	20
+3/-8	0	-30	-30
+4/-9	7	42	-35

Operator: PD-DSM \ WK-KVA Date: 9/12/95

Station: PD-15 Time: S=1600 N=1645

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 32.5 ft BTOC

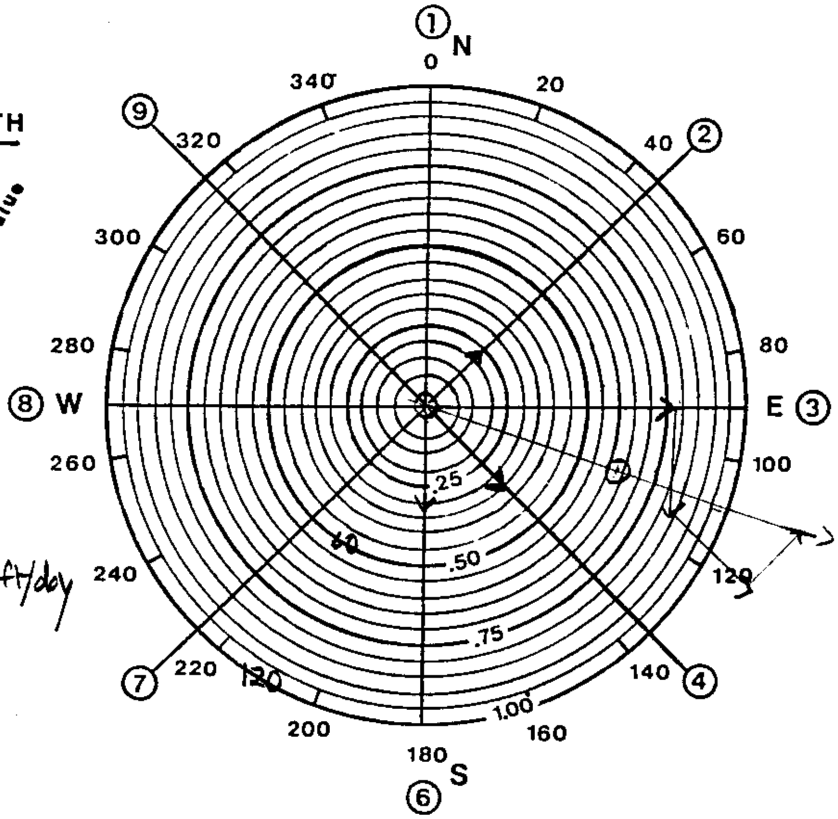
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{max. value}$
+1/-6	13	88	75	-40.5	
+2/-7	15	-23	-38	29	
+3/-8	-19	-243	-224	97	
+4/-9	-7	-126	119	42	

$\frac{75}{33}$ = 2.27 ft/day

± 109°

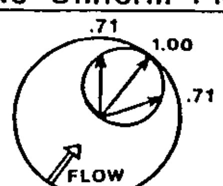


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 109° Velocity: 2.27 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: PD-DSM|UK-KVA	Date: 9/12/95
Station: PD-16	Time: N=1730 S=1800
Location: CORCO	
Soil Conditions: PONCE LIMESTONE	
Depth to Measurement: 48 ft BTOC	

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	7	0	-7
+2/-7	16	23	7
+3/-8	0	-27	-27
+4/-9	2	29	27

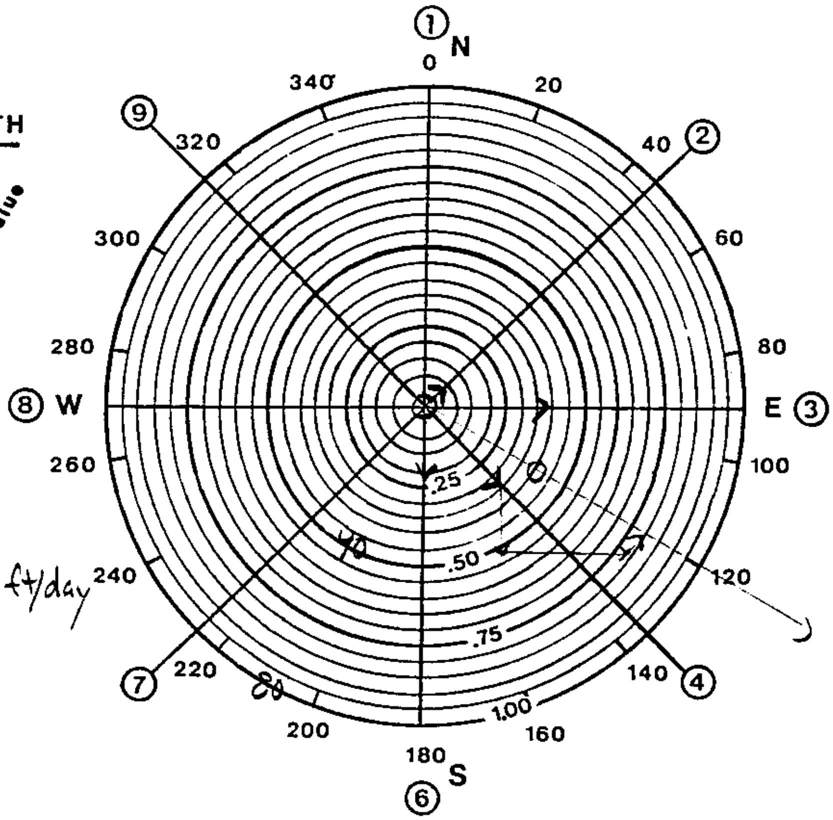
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F/max. value
+1/-6	7	36	29	-18	
+2/-7	15	8	-7	7	
+3/-8	0	-89	-89	31	
+4/-9	2	-25	-27	27	

$\frac{32}{33}$ = 0.97 ft/day

± 120°

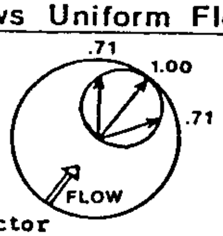


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 120°	Velocity: 0.97 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PD-OSM/WK·KVA Date: 9/15/95

Station: PD-16 Time: N=1450 S=1510

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 38.5 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	6	22	16
+2/-7	16	36	20
+3/-8	0	-93	-93
+4/-9	3	-8	-11

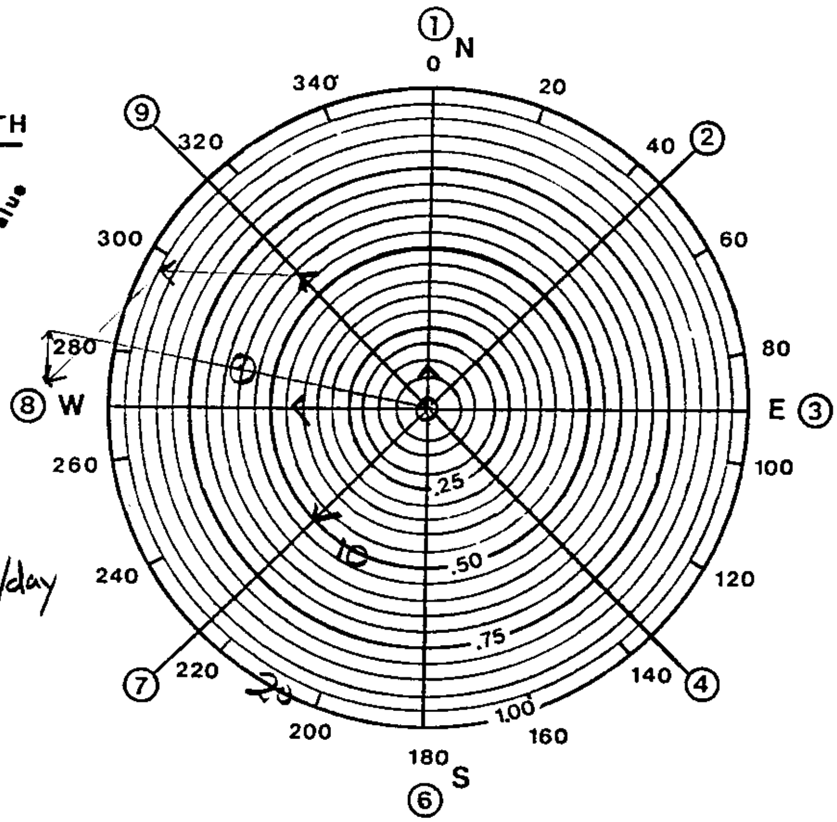
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F / max. value
+1/-6	7	18	11	2.5	
+2/-7	16	56	40	-10	
+3/-8	0	-76	-76	-8.5	
+4/-9	2	18	16	-13.5	

$\frac{12.25}{33} = 0.37$ ft/day

≈ 281°

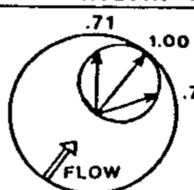


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59•HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 281° Velocity: 0.37 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	8	70	62
+2/-7	17	28	11
+3/-8	-3	-95	-92
+4/-9	2	-23	-25

Operator: PO-DSM/WK-KVA Date: 9/15/95

Station: PO-16 Time: N-1610 S-1550

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 38.5 ft BTOC

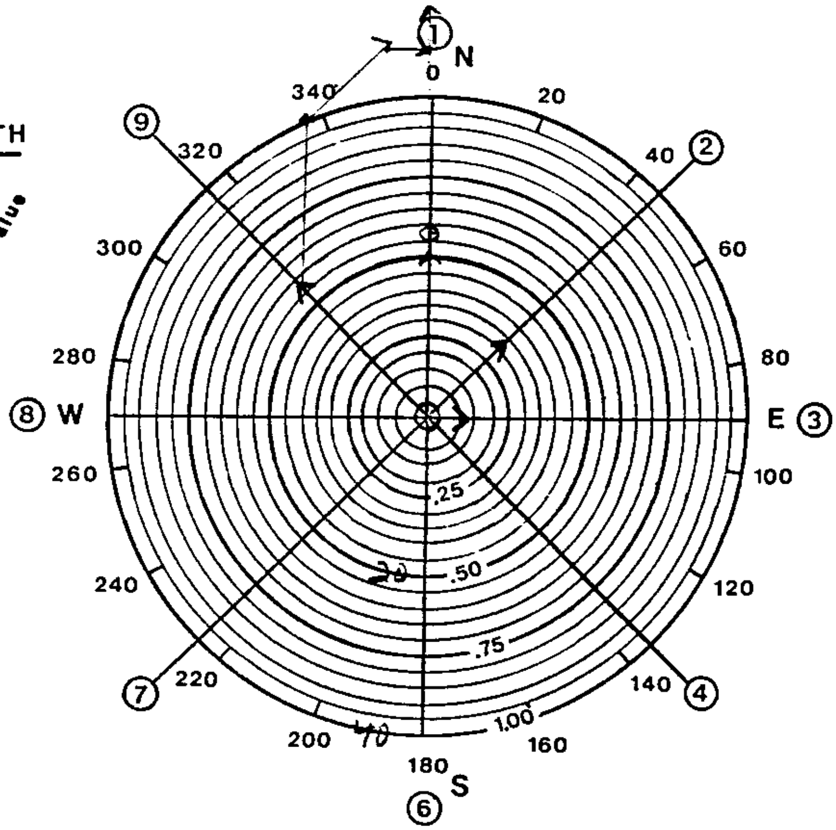
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{\text{max. value}}$
+1/-6	8	29	21	20.5	
+2/-7	17	1	-16	13.5	
+3/-8	-8	-110	-102	5	
+4/-9	5	27	22	-23.5	

$\frac{23}{33}$ = 0.70 ft/day

≈ 359°

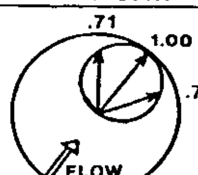


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 359° Velocity: 0.70 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PD-DSM\WK-KVA Date: 9/15/95

Station: PD-18 Time: S=1115 N=1145

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 34.5 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	9	29	20
+2/-7	20	45	25
+3/-8	3	-66	-69
+4/-9	3	-18	-21

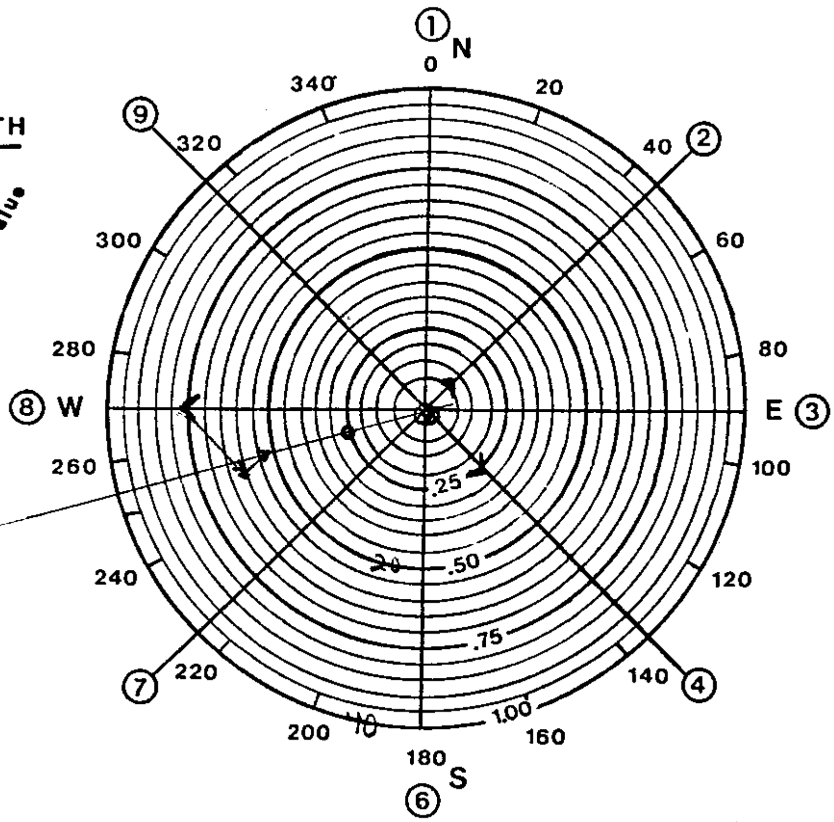
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{max. value}$
+1/-6	8	30	22	-1	
+2/-7	16	31	15	5	
+3/-8	0	-8	-8	-30.5	
+4/-9	2	-40	-42	10.5	

$\frac{10.5}{33}$ = 0.32 ft/day

± 254°

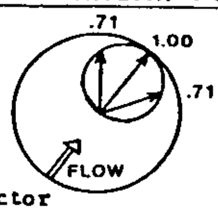


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 254° Velocity: 0.32 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	7	14	7
+2/-7	15	5	-10
+3/-8	-7	-66	-59
+4/-9	3	-16	-19

Operator: PD-DEM\WK-KVA Date: 9/15/95

Station: PD-18 Time: N=1032 S=1046

Location: CORCO

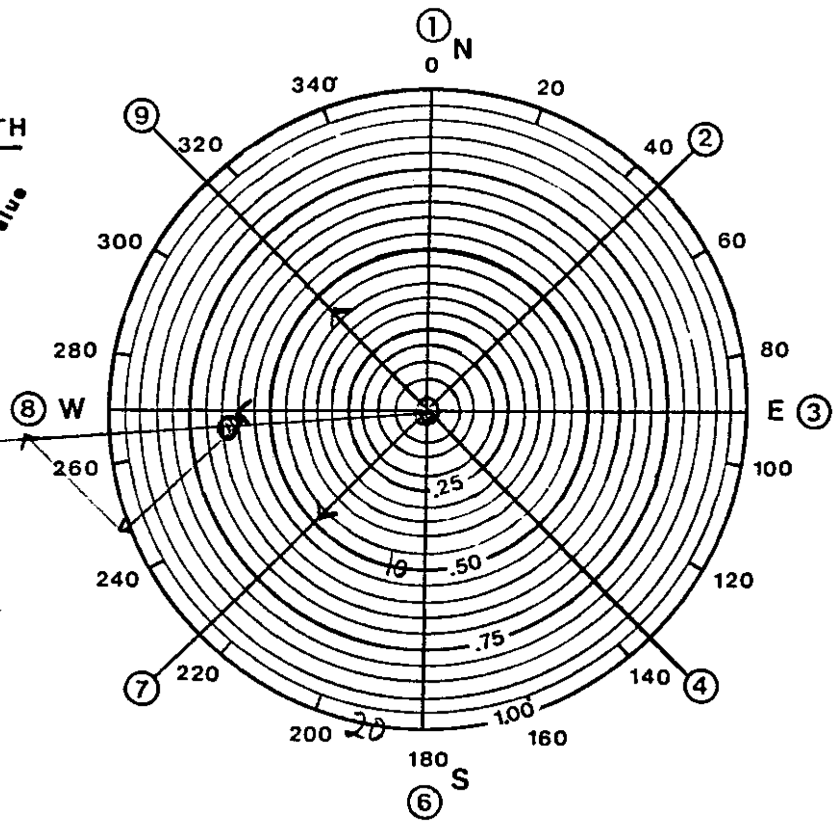
Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 41 ft BTOC

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{\text{max. value}}$
+1/-6	9	18	9	-1	
+2/-7	18	27	9	-9.5	
+3/-8	0	-35	-35	-12	
+4/-9	2	0	-2	-8.5	



$\frac{12.5}{33} = 0.38$ ft/day

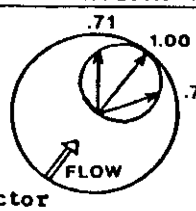
± 266°

Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 266°	Velocity: 0.38 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PD-DSM\WL-KVA Date: 9/14/95

Station: PD-21 Time: S = 1712 N = 1650

Location: CORCO

Soil Conditions: Ponce Limestone

Depth to Measurement: 117.5 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	7	18	11
+2/-7	16	-21	-37
+3/-8	0	-120	-120
+4/-9	3	-55	-58

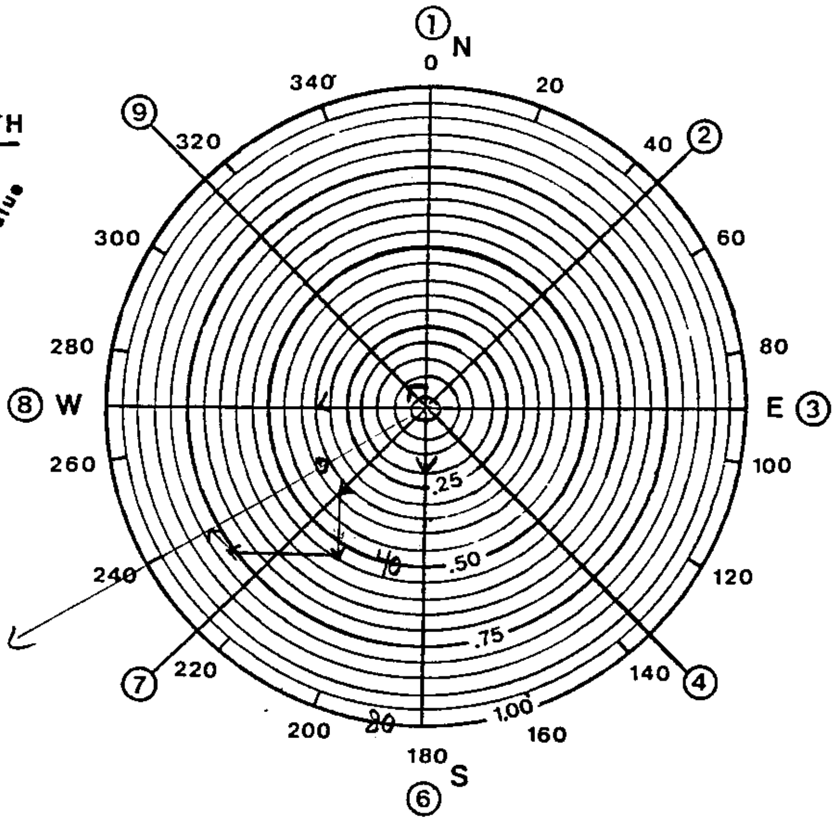
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{max. value}$
+1/-6	8	51	43	-16	
+2/-7	16	42	26	-31.5	
+3/-8	0	-65	-65	-27.5	
+4/-9	2	-41	-43	-7.5	

$\frac{31}{33}$ = 0.94 ft/day

± 240°

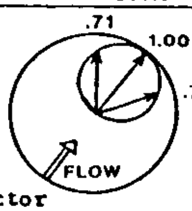


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 240° Velocity: 0.94 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: PD-DSM\WK-KVA Date: 9/14/95
Station: PD-25 Time: N= 1202 S= 1145
Location: CORCO
Soil Conditions: PONCE LIMESTONE
Depth to Measurement: 141 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	9	182	173
+2/-7	16	82	66
+3/-8	0	-136	-136
+4/-9	3	-98	-101

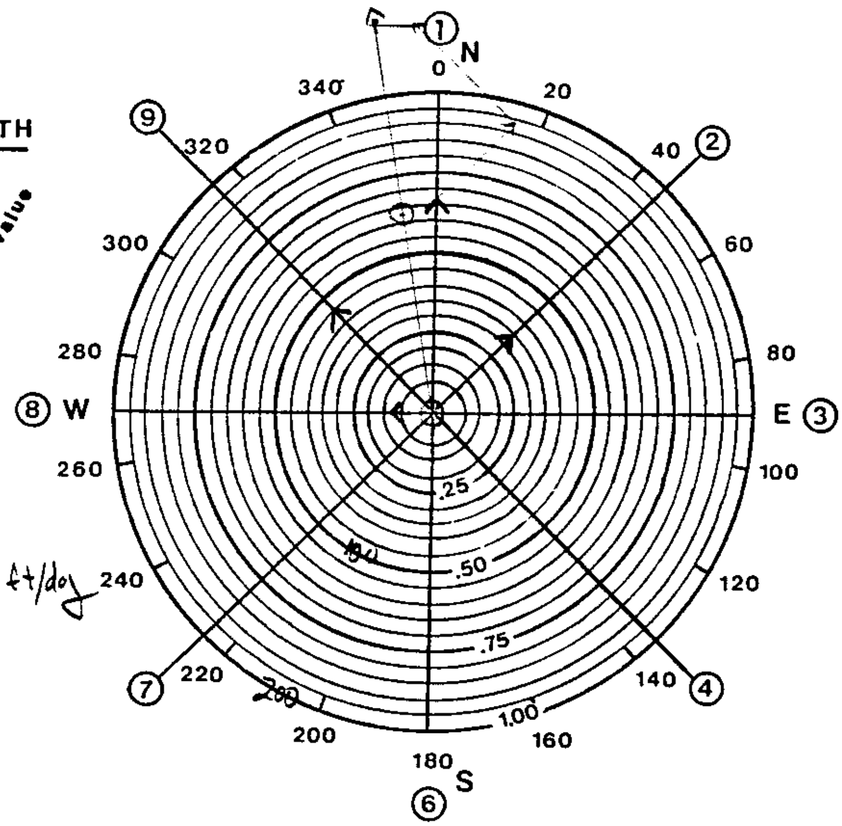
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{\text{max. value}}$
+1/-6	7	-87	-94	133.5	
+2/-7	16	-57	-73	69.5	
+3/-8	0	-83	-83	-26.5	
+4/-9	3	82	79	-90	

$\frac{125}{33}$ = 3.79 ft/day

≈ 351°

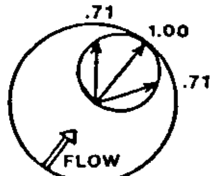


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 351° Velocity: 3.79 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PD-DSM/WK-KVA Date: 9/14/95

Station: PD-25 Time: S= 1345 N= 1605

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 141 BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	9	185	176
+2/-7	14	102	88
+3/-8	-6	-101	-95
+4/-9	0	-120	-120

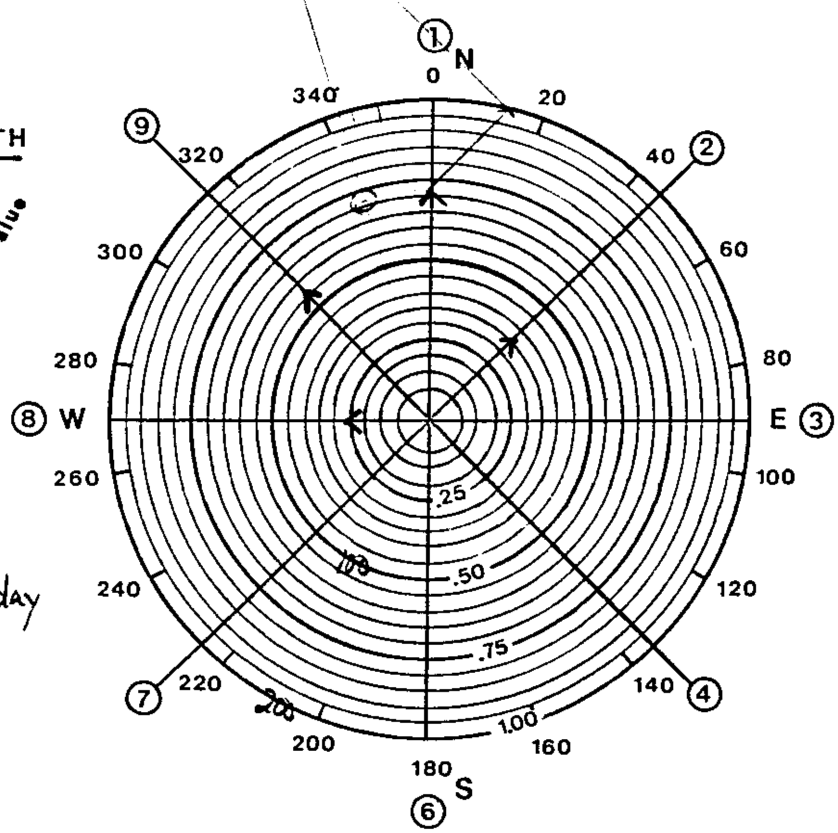
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{max. value}$
+1/-6	7	702	-109	142.5	
+2/-7	15	-39	-54	71	
+3/-8	0	8	8	-51.5	
+4/-9	3	107	104	-112	

$\frac{143}{33} = 4.33$ ft/day

I 343°

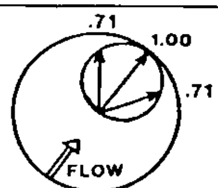


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 343° Velocity: 4.33 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: PD-DEM\WK-KVA Date: 9/14/95

Station: PD-25 Time: N= 1100 S= 1120

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 155 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	8	49	+41
+2/-7	19	37	+18
+3/-8	0	-70	-70
+4/-9	3	-29	-32

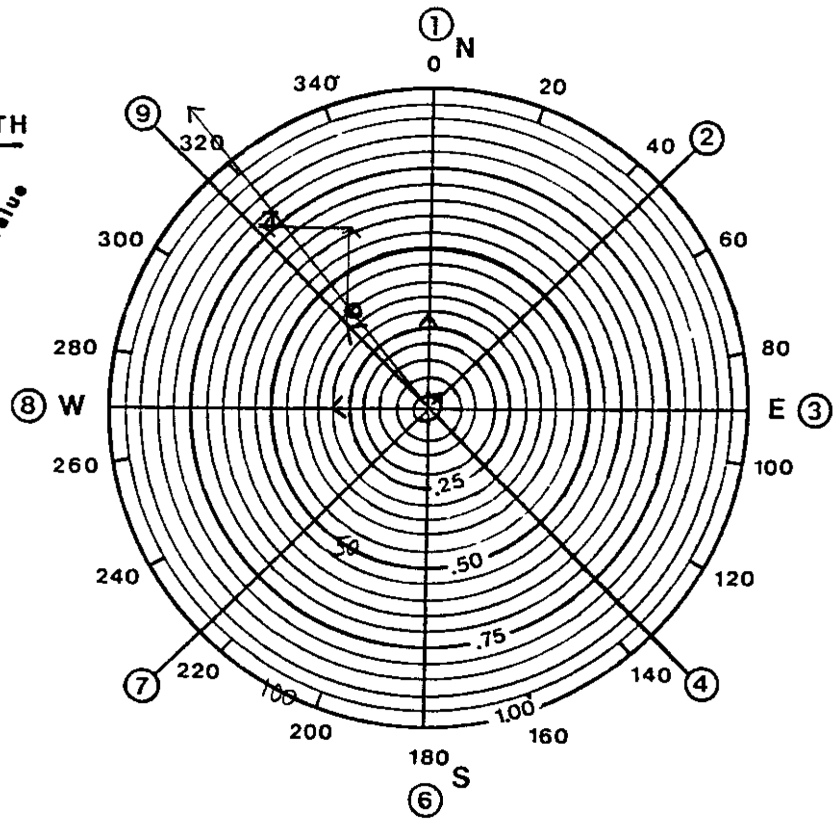
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{\text{max. value}}$
+1/-6	9	-8	-17	29	
+2/-7	13	18	5	6.5	
+3/-8	-8	-18	-10	-30	
+4/-9	0	40	40	-36	

$\frac{39}{33}$ = 1.18 ft/day

± 321°

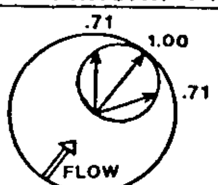


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 321° Velocity: 1.18 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PD-DSM/WK-KVA Date: 9/14/95

Station: PD-25 Time: N=1305 S=1328

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 155 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	7	57	50
+2/-7	18	11	-7
+3/-8	-6	-106	-100
+4/-9	6	-68	-74

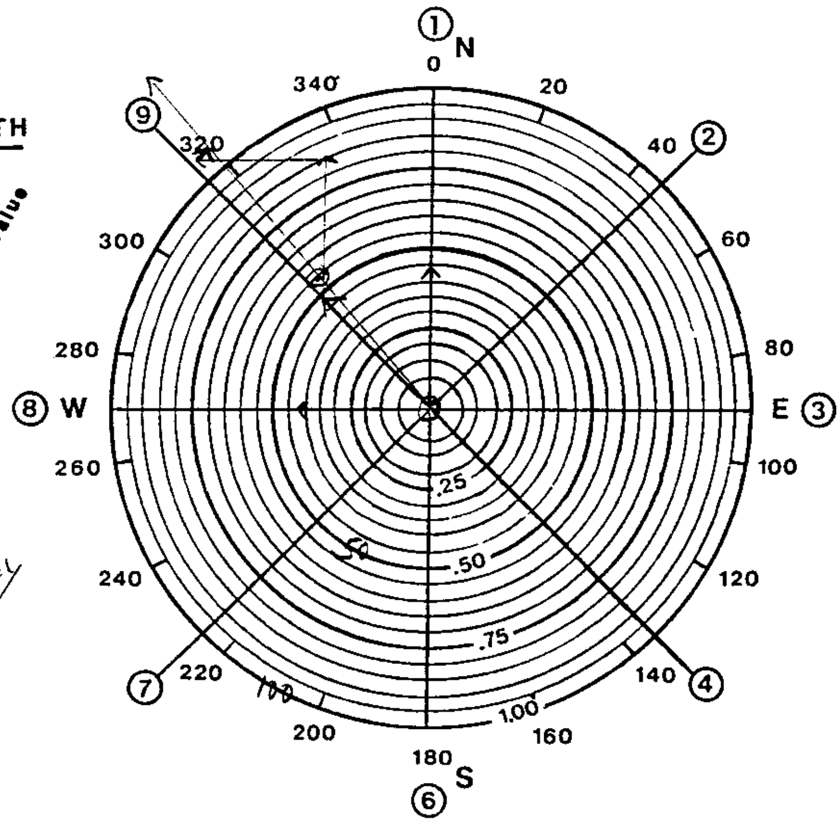
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{\text{max. value}}$
+1/-6	8	-31	-39	44.5	
+2/-7	16	0	-16	4.5	
+3/-8	-6	-21	-15	-42.5	
+4/-9	2	23	21	-47.5	

$\frac{54}{33} = 1.64$ ft/day

I 319°

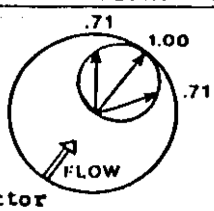


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 319° Velocity: 1.64 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	6	-18	-24
+2/-7	17	-43	-60
+3/-8	0	-106	-106
+4/-9	2	-22	-24

Operator: PD-DSM/WK-KVA Date: 9/15/95

Station: PD-29 Time: N=0845 S=0900

Location: CORCO

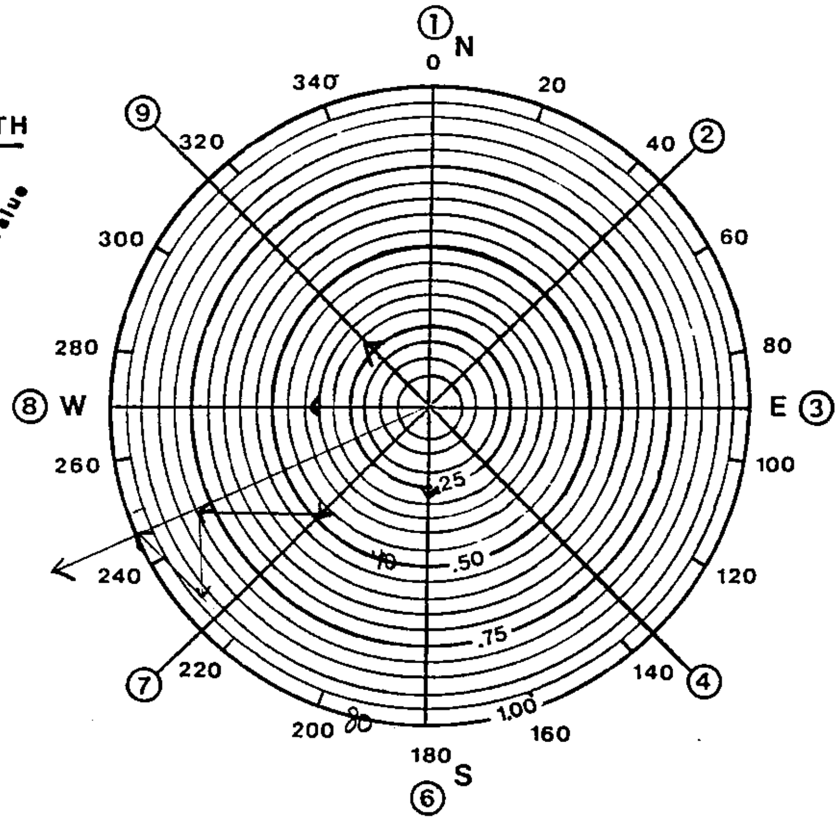
Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 118 ft BTOC

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{max.\ value}$
+1/-6	7	28	21	-22.5	
+2/-7	18	35	17	-38.5	
+3/-8	1	-44	-45	-30.5	
+4/-9	4	25	21	-22.5	



$\frac{40}{33} = 1.21$ ft/day

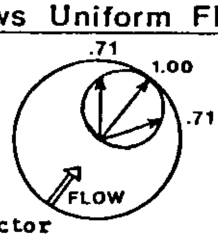
≈ 246°

Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 246° Velocity: 1.12 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: PD-DSM\WK-KVA Date: 9/15/95

Station: PD-29 Time: N=0845 S=0926

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 118 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	6	-18	-24
+2/-7	17	-43	-60
+3/-8	0	-106	-106
+4/-9	2	-22	-24

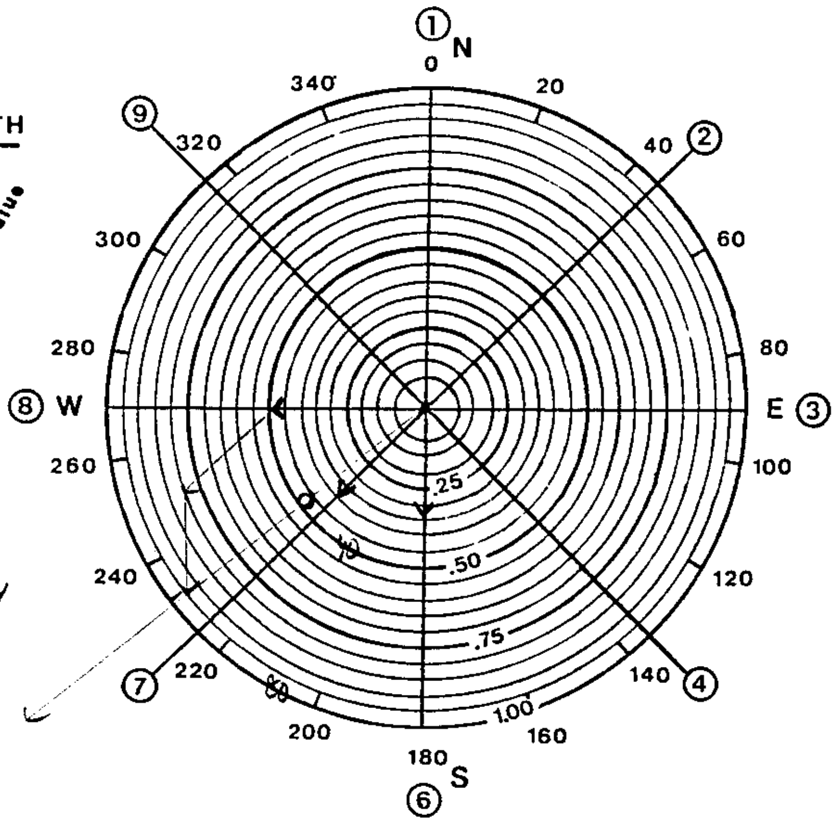
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F / max. value
+1/-6	5	36	31	-27.5	
+2/-7	21	22	1	-30.5	
+3/-8	3	-70	-67	-39	
+4/-9	12	-12	-24	0	

$\frac{39}{33} = 1.18$ ft/day

± 229°

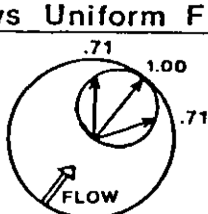


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 229° Velocity: 1.18 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PD-DSM|WK-KVA Date: 9/13/95

Station: MW-02 Time: N=1552 S=1628

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 197 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	8	12	4
+2/-7	17	12	-5
+3/-8	0	-54	-54
+4/-9	1	-12	-13

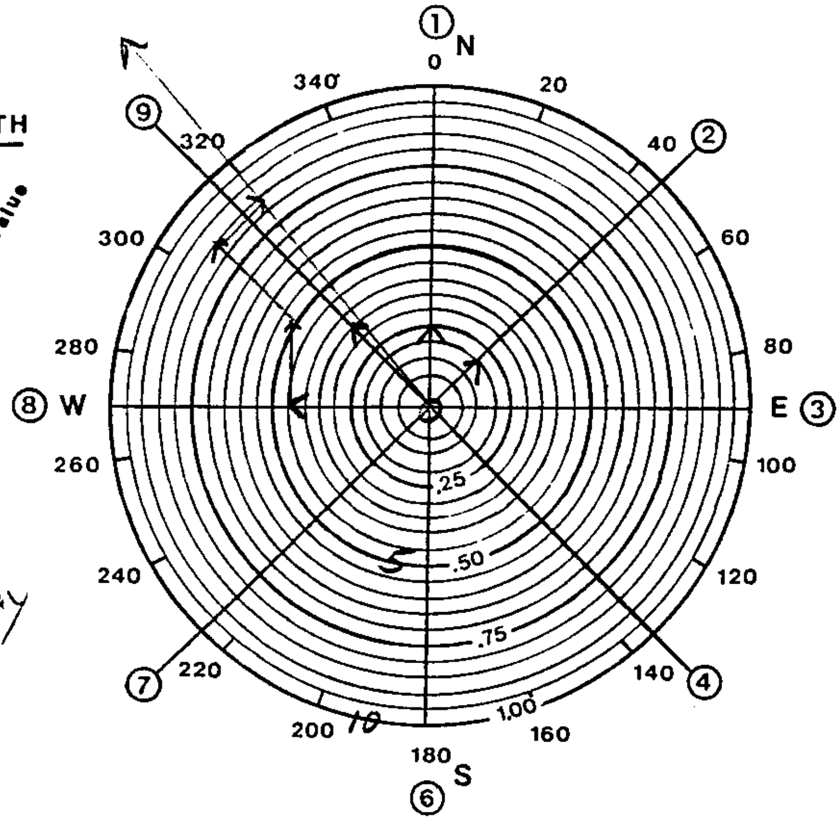
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{\text{max. value}}$
+1/-6	7	6	-1	2.5	
+2/-7	18	9	-9	2	
+3/-8	0	-45	-45	-4.5	
+4/-9	2	-4	-6	-3.5	

$\frac{4.25}{33} = 0.13$ ft/day

± 320°

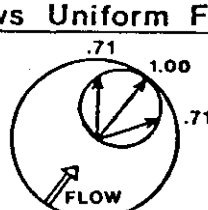


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 320 Velocity: 0.13 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: PD-DSM/WK-KVA Date: 9/13/95

Station: MW-02 Time: N=1610 S=1645

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 197.5 ft BTOC

Table of LCD Readout

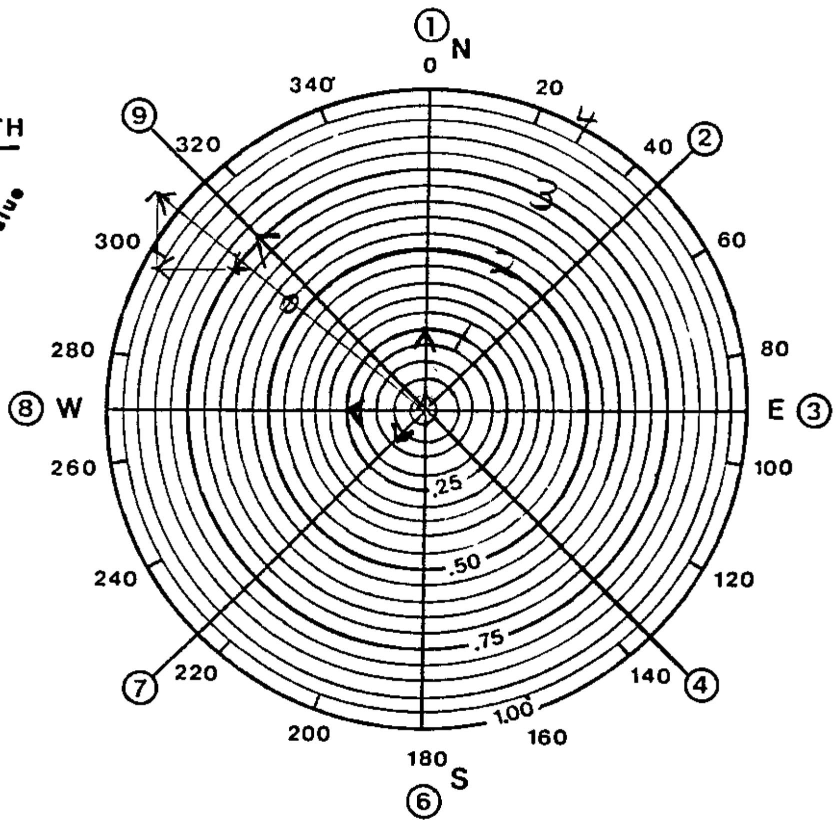
1→N

Probe pair	A start	B end	C B-A
+1/-6	11	12	1
+2/-7	19	11	-8
+3/-8	-8	-57	-49
+4/-9	0	-13	-13

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F/max. value
+1/-6	10	9	-1	1	
+2/-7	20	13	-7	-.5	
+3/-8	0	-47	-47	-1	
+4/-9	1	-6	-7	-3	



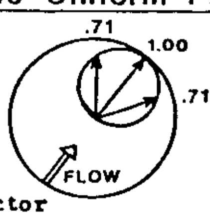
$\frac{2.2}{33}$ = 0.07 ft/day ± 310°

Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 310° Velocity: 0.07 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: PD-DSM/WK-KVA Date: 9/13/95

Station: MW-02 Time: S= 1720 N= 1735

Location: CORCO

Soil Conditions: PONCE LIMESTONE

Depth to Measurement: 202.5 ft BTOC

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	8	25	17
+2/-7	17	23	6
+3/-8	0	-52	-52
+4/-9	2	-16	-18

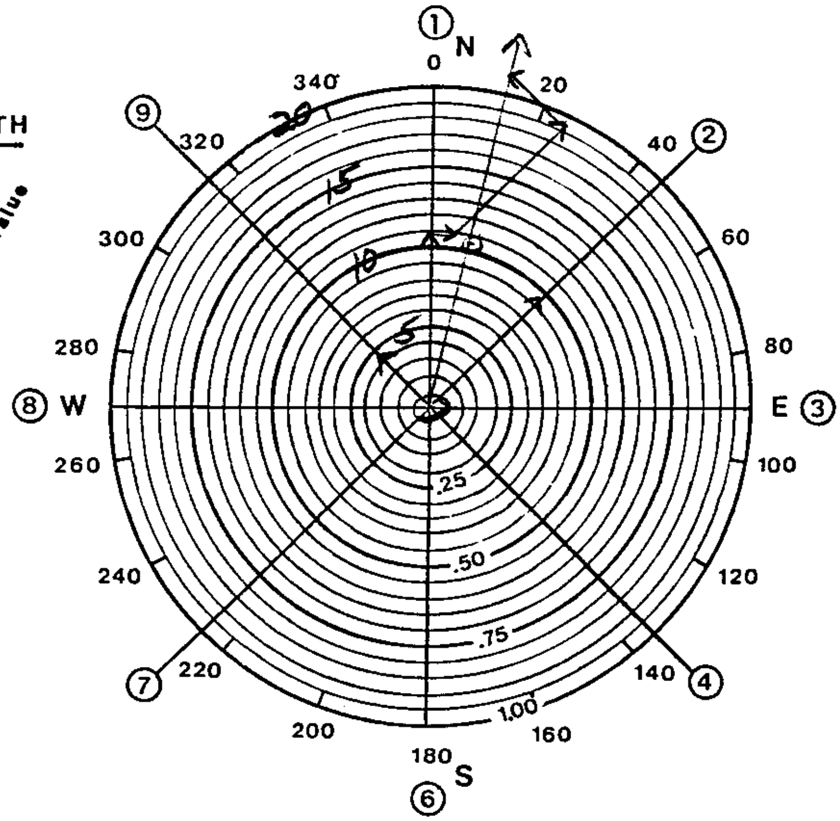
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F / max. value
+1/-6	8	3	-5	11	
+2/-7	17	4	-13	9.5	
+3/-8	0	-54	-54	1	
+4/-9	2	-7	-9	-4.5	

$\frac{10.5}{33} = 0.32$ ft/day

∠13°

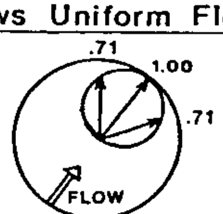


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 13° Velocity: 0.32 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: PD-DSM / WK-KVA	Date: 9/14/95
Station: MW-05	Time: N=0830 S=0850
Location: CORCO	
Soil Conditions: PONCE LIMESTONE	
Depth to Measurement: 175.5 ft/BTOC	

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	6	-6	-12
+2/-7	16	-38	-54
+3/-8	0	-28	-28
+4/-9	2	0	-2

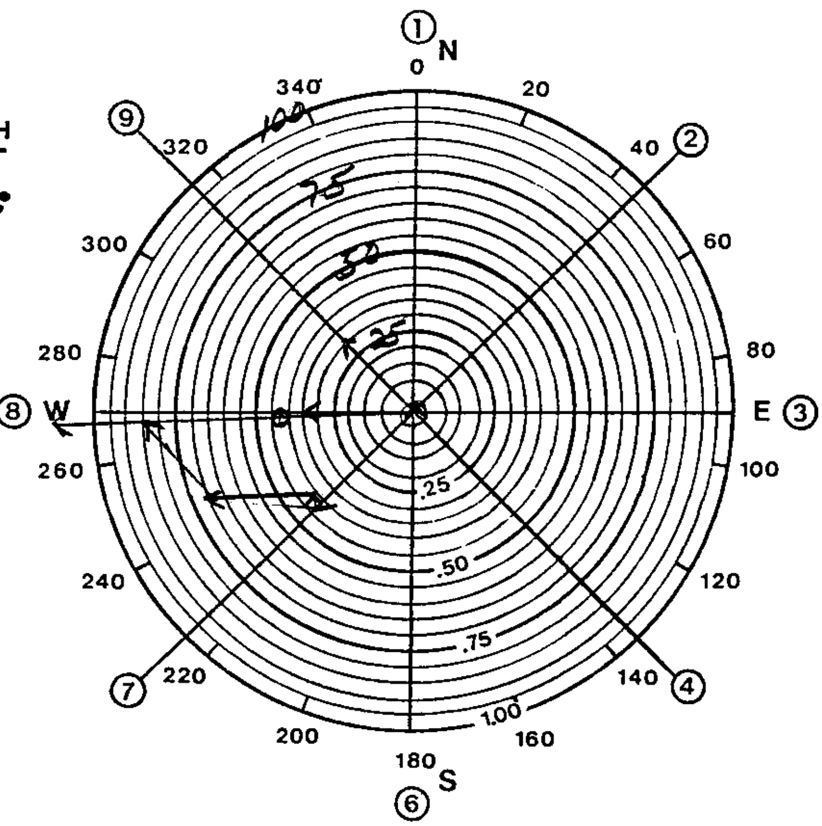
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F N-S/2	G F/max. value
+1/-6	7	-13	-20	4	
+2/-7	18	52	34	-44	
+3/-8	0	40	40	-34	
+4/-9	2	62	60	-31	

$\frac{43}{33}$ = 1.30 ft/day

± 268°

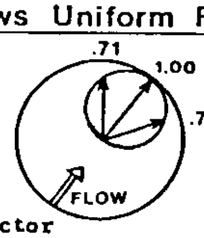


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 268°	Velocity: 1.30 ft/day

Form 104 available from your local K-V Associates, Inc. dealer.

APPENDIX C-3
IN-SITU FLUID FLOW CALIBRATION DATA

·THE FAX FROM

K-V ASSOCIATES, INC.
ANALYTICAL SYSTEMS

281 MAIN ST, BOX 574, FALMOUTH, MA 02541

(508) 540-0561
FAX (508) 457-4810

TO: PETE DOTSEY

FROM: BILL KERFOOT, KVA

FAX #: (713) 870-0161 PHONE #: (713) 870-8676

RE: FLOW CORRECTION FACTOR FOR 20 SLOT BK PVC SCREEN

DATE: 9/19/95 TOTAL PGS. INC. COVER: 9 pg

COMMENTS:

PETE:
WE SPENT 2 HRS CHECKING THE 20 SLOT SCREEN. THE DIFFERENCE WITH 10 SLOT BK PVC MONITORING WELL IS ABOUT 16.6 % BETTER FLOW. YOU WOULD HAVE TO CORRECT YOUR READINGS BY .834 TO OBTAIN THE TRUE FLOW, CORRECTED FOR WIDER SLOT SIZE. THIS IS VALID FOR THE .5 TO 3.0 ft/d RANGES SINCE THE FACTOR VARIES.

BK

IF YOU DO NOT RECEIVE ALL THE PAGES, PLEASE CALL (508) 540-0561.

GROUNDWATER FLOW WORKSHEET

• For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Operator: *Lina* Date: *7/18/95*

Station: *Calibration* Time: *2:00PM*

Location: *~~20~~ 10 Slot B-K PVC Monitoring Screen*

Soil Conditions: *Medium Sand*

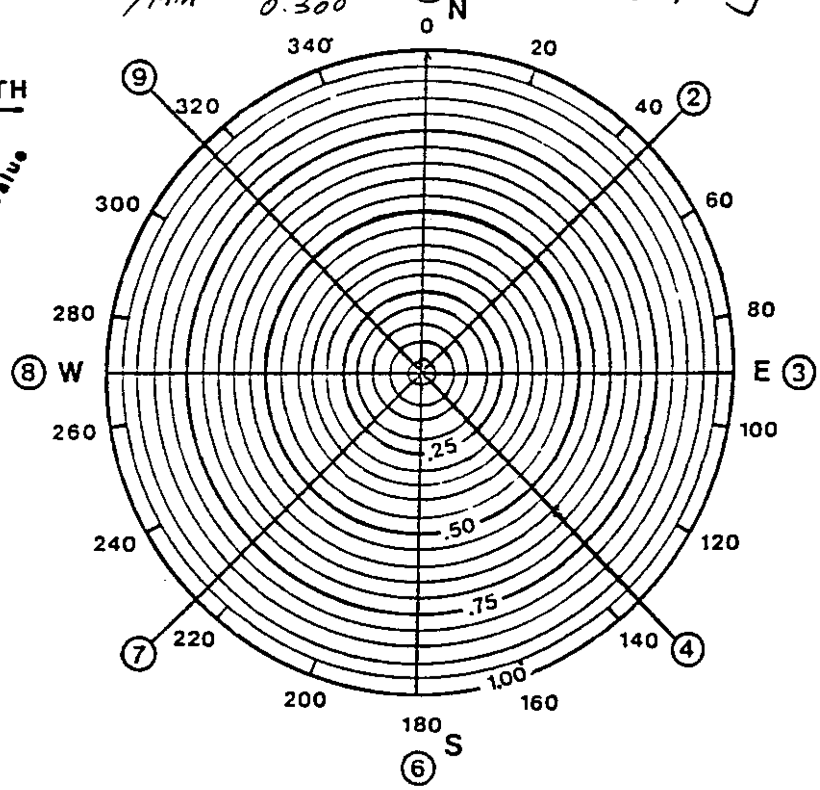
Depth to Measurement: *1 ft*

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	+9	+300	+293
+2/-7	+23	+208	+215
+3/-8	+3	-72	-75
+4/-9	+2	-201	-203

*flowRate = 35.2 cc/Min * $\frac{0.146}{0.300}$ ① N = 17.1 ft/day*



ROTATE PROBE 180° AT SAME DEPTH

1→S

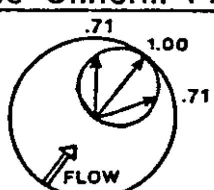
Probe pair	D start	E end	S E-D	N-S / 2	G F / max. value
+1/-6	-21	-305	-284	+2885	+1
+2/-7	+0	-194	-194	+2045	+0.7
+3/-8	-8	-78	-70	-5	-0.017
+4/-9	+17	+172	+155	-179	-0.62

Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59+HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: ________ Velocity: ________

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

1.9 AMPS

Operator: W. Kerfoot	Date: 9/8/95
Station: CAL CHAMBER / LAB	Time: 8:10PM
Location: CALIBRATION - FINE/MED SAND	
Soil Conditions: BRAINARD KILMAN 10 SLOT PVC PLASTIC WRAPPED	
Depth to Measurement: 1 ft	

$36\ ml/min \times \frac{.146}{.30} = 17.52$ ① ft/day

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	+0	+268	+268
+2/-7	+13	+211	+198
+3/-8	+0	-38	-38
+4/-9	+6	-186	-192

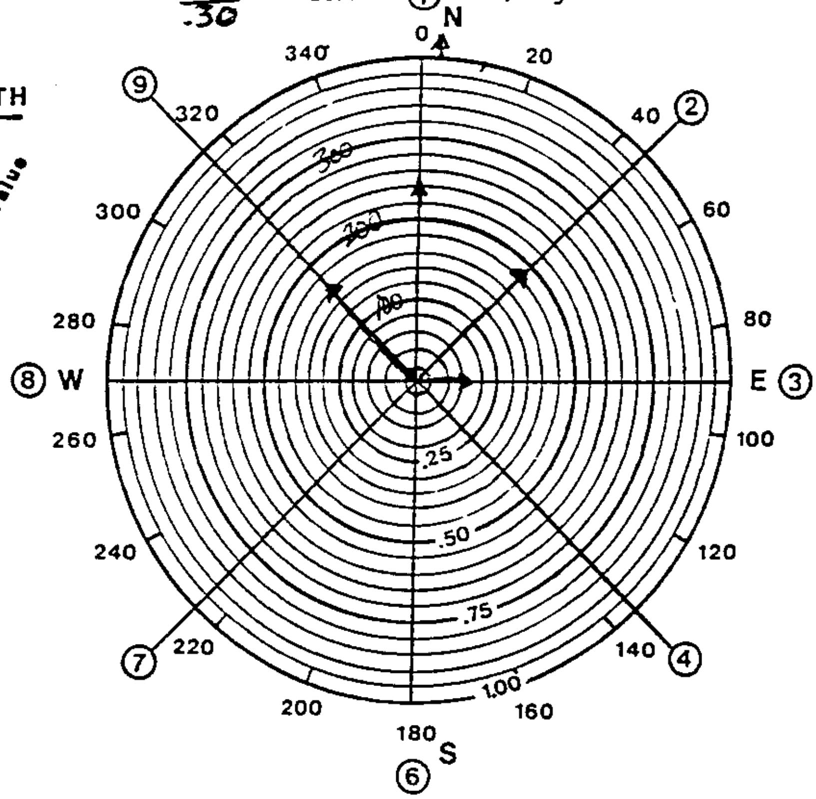
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D		F $\frac{N-S}{2}$	G $\frac{F}{max.\ value}$
+1/-6	-22	-257	-235	$\frac{+268+235}{2}$	+251.5	
+2/-7	-6	-203	-197	$\frac{198+197}{2}$	+197.5	
+3/-8	-7	-113	-106	$\frac{-38+106}{2}$	+72	
+4/-9	+17	+151	+134	$\frac{-192-134}{2}$	-163	

14.3 ×

17.5) 251

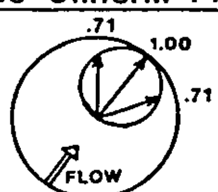


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 30°	Velocity: 17.5 ft/d

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	+5	-139	-134
+2/-7	+17	+98	+81
+3/-8	+0	-67	-67
+4/-9	+2	-100	-102

Operator: B. KERFOOT Date: 9/8/96

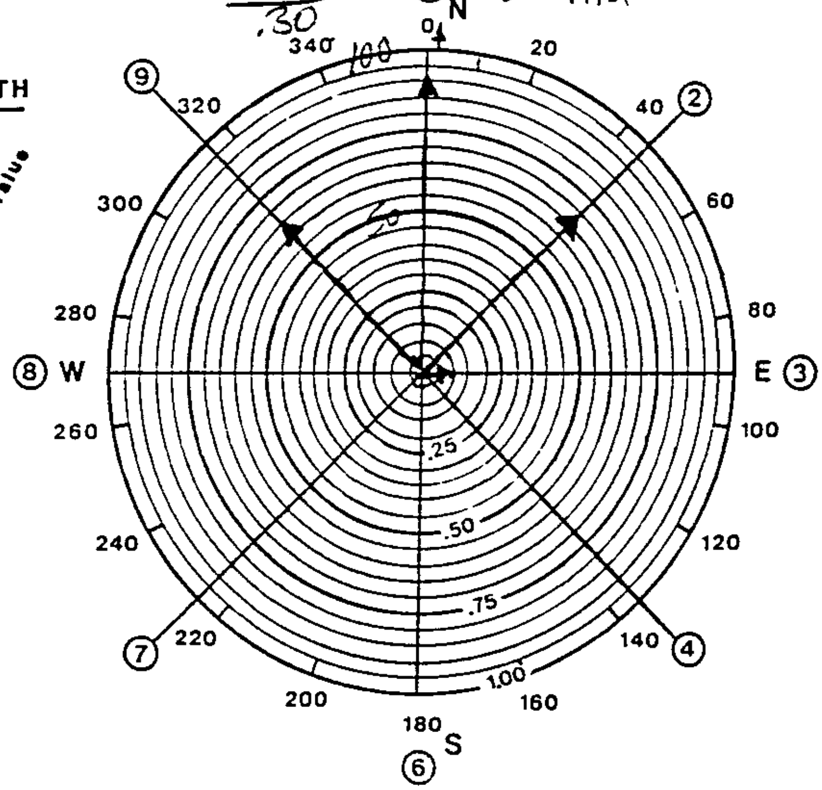
Station: CALIBRATION Time: 9:30 PM

Location: BENWARD KUHAN 10 SLOT, WRAPPED PVC

Soil Conditions: MED/FINE SAND

Depth to Measurement: 1 ft

$17cc/MIN \times \frac{.146}{.30} = $ ① 8.3 ft/d



ROTATE PROBE 180° AT SAME DEPTH

1→S*

Probe pair*	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{max. value}$
+1/-6	+1	-48	-49	+92	
+2/-7	+14	-41	-55	+68	
+3/-8	+0	-84	-84	+8.5	
+4/-9	+4	+25	+21	-61.5	

$\frac{+134+49}{2}$ $\frac{+81+55}{2}$ $\frac{-67+84}{2}$ $\frac{-102-21}{2}$

* AIRBUBBLES IN LINE

11.1 x

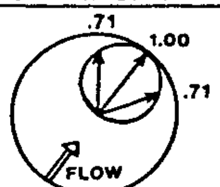
8.3 ⟌ 92

Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 2° Velocity: 8.3 ft/d

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, **4 channel probe**

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	+8	+104	+96
+2/-7	+19	+61	+42
+3/-8	+0	-100	-100
+4/-9	+1	-95	-96

Operator: W. Kerfoot Date: 9/8/95

Station: CALIBRATION Time: 10:00PM

Location: BRAINARD-KILMAN 10 SLOT, WRAPPED SCREEN, PVC

Soil Conditions: FINE/MED SAND

Depth to Measurement: ______

4.83 cc/min × $\frac{.146}{.30}$ = ① 2.35 ft/d

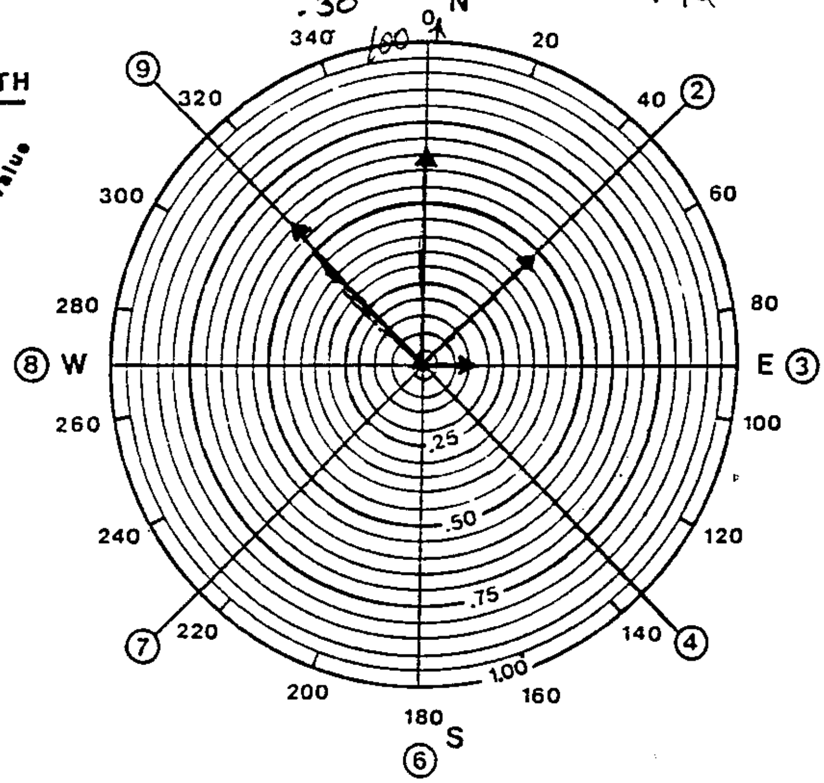
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D		F $\frac{N-S}{2}$	G $\frac{F}{max. value}$
+1/-6	+8	-30	-38	$\frac{96+38}{2}$	+67	
+2/-7	+19	-36	-55	$\frac{+42+55}{2}$	+48.5	
+3/-8	+0	-130	-130	$\frac{-100+130}{2}$	+15	
+4/-9	+1	+30	+29	$\frac{-96-29}{2}$	-62.5	

27.9 UNITS

24 √67

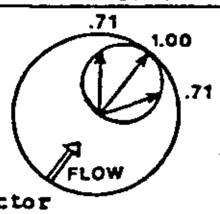


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: 2° Velocity: 2.35 ft/d

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: *Lina*	Date: *9/18/95*
Station: *Calibration*	Time: *2:40PM*
Location: *20 Slot B-K PVC*	
Soil Conditions: *M Sand*	
Depth to Measurement: *1ft*	

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	+1	+142	+141
+2/-7	+14	+90	+76
+3/-8	+0	−105	−105
+4/-9	+6	−103	−108

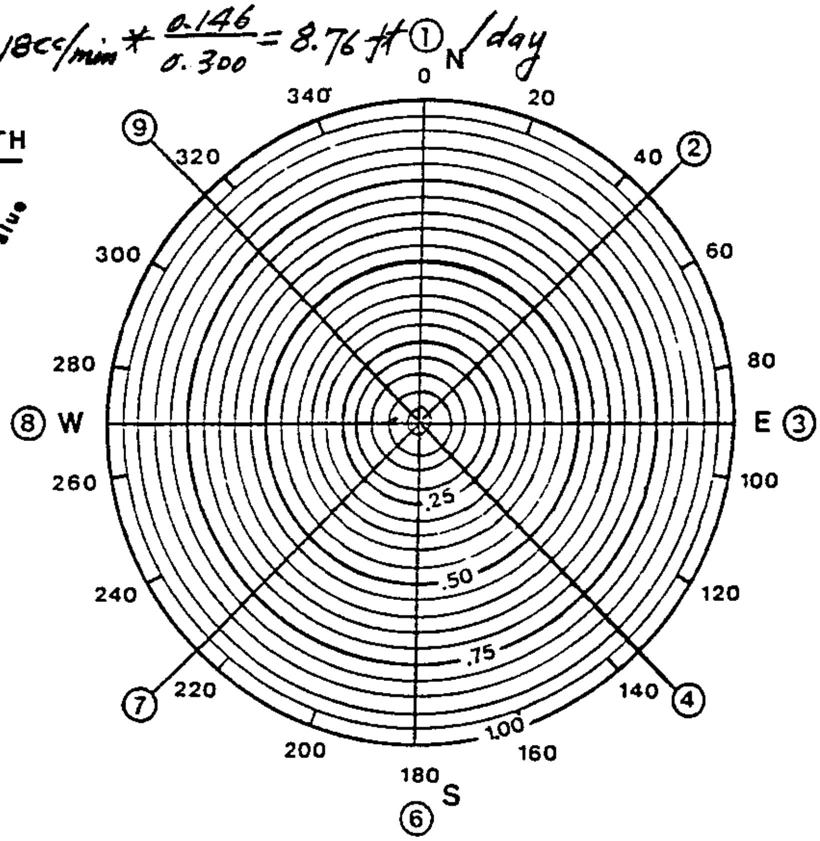
*flowRate = 18cc/min * $\frac{0.146}{0.300}$ = 8.76 ft/day*

ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{\text{max. value}}$
+1/-6	+1	−147	−148	+144.5	+1
+2/-7	+8	−103	−110	+93	+0.64
+3/-8	−17	−87	−70	−35	0.24
+4/-9	0	+78	+78	−93	−0.64

16.49
8.76⟌144.5

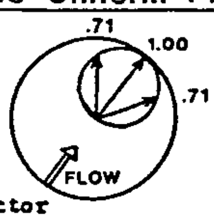


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: ________	Velocity: ________

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

Operator: Lina Date: 9/18/95

Station: Calibration Time: ~~3~~ 3:15PM

Location: 20 slot B-K PVC

Soil Conditions: M Sand

Depth to Measurement: 1 ft

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	+6	+100	+94
+2/-7	+19	+51	+32
+3/-8	+1	-135	-136
+4/-9	+1	-94	-95

flowrate = 8cc/min $\ast \frac{0.146}{0.300} = 3.89$ ft/day

ROTATE PROBE 180° AT SAME DEPTH

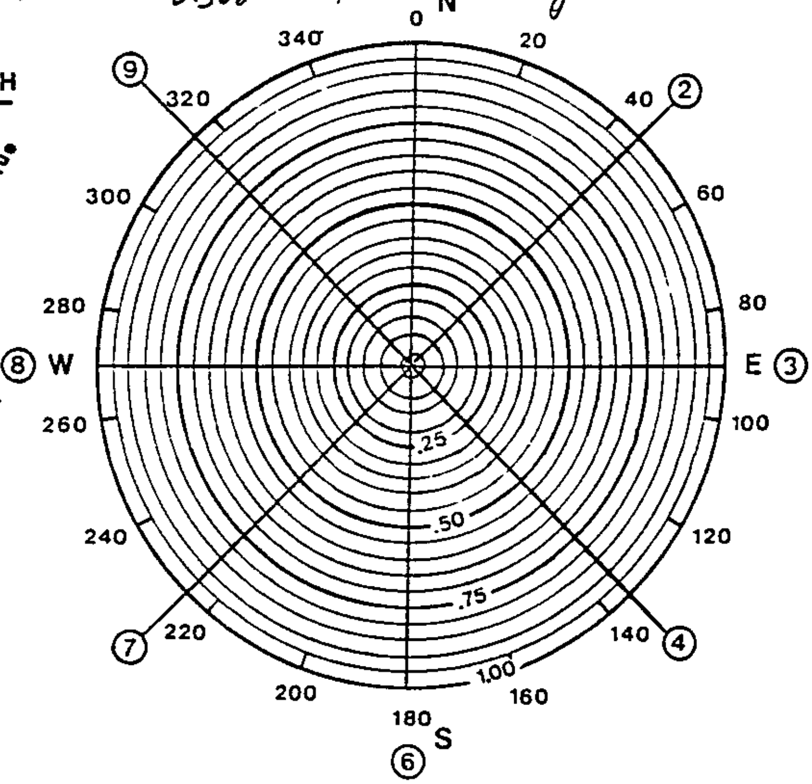
1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G F/max. value	
+1/-6	+4	-92	-96	+95	~~96~~	1
+2/-7	+15	-59	-74	53	+ ~~[illegible]~~	+0.34
+3/-8	-8	-91	-83	-53	- ~~[illegible]~~	-0.34
+4/-9	0	+61	+61	-78 ~~136~~	4	0.82

-78

$\frac{-95-61}{2}$

24.4
3.89) 95

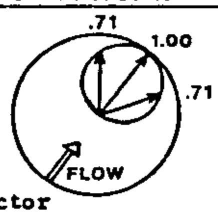


Use of Table

COLUMN G - Divide each reading in column F by the largest absolute value. Draw these 4 vectors on the circle chart according to the scale provided (i.e. strongest vector = 1.00).

Cosine Test Shows Uniform Flow

Vector end points will closely fit a circle inscribed about the longest vector. Values in column G will approximate vector lengths shown at right.



Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction: ______ Velocity: ______

Form 104 available from your local K-V Associates, Inc. dealer.

GROUNDWATER FLOW WORKSHEET

For use with K-V Associates, Inc. Groundwater Flowmeters, 4 channel probe

1.9A

Table of LCD Readout

1→N

Probe pair	A start	B end	C B-A
+1/-6	+5	+49	+44
+2/-7	+18	+22	+4
+3/-8	+0	-139	-139
+4/-9	+2	-61	-63

Operator: Lina Date: 9/18/95

Station: Calibration Time: 4:00pm

Location: 20 Slot B-K PVC Monitoring ~~Screen~~ Screen

Soil Conditions: M ~~Sand~~ Sand

Depth to Measurement: 1 ft

flowrate = 2.2cc/min * $\frac{0.146}{0.300}$ = 1.07 ft/day

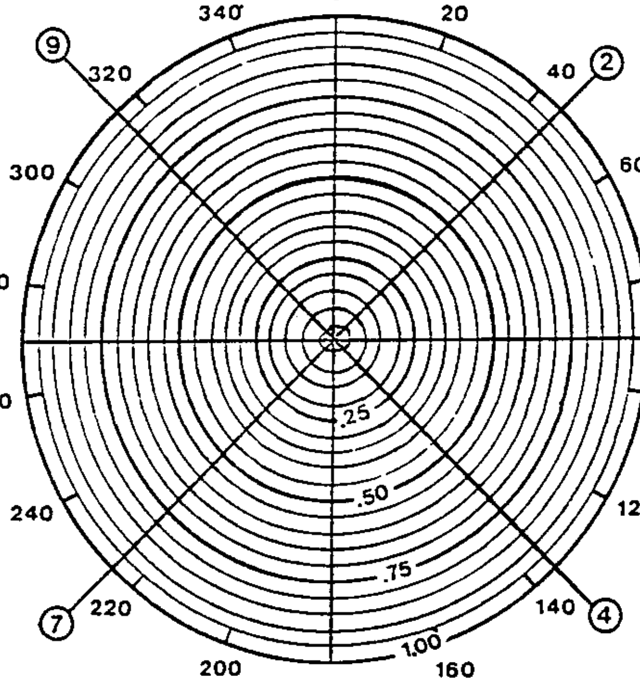
ROTATE PROBE 180° AT SAME DEPTH

1→S

Probe pair	D start	E end	S E-D	F $\frac{N-S}{2}$	G $\frac{F}{\text{max. value}}$
+1/-6	+7	-32	-39	+41.5	+~~0.9~~ 0.62
+2/-7	+19	-10	-39	+21.5	+0.32
+3/-8	+0	-72	-72	-67	-1
+4/-9	+1	+26	+25	-44	-0.65

38.7 UNITS

1.07 ⟌ 41.5



Use of Table

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Cosine Test Shows Uniform Flow

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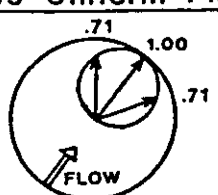


Vector Resolution to Determine Direction

1. Use KVA Vector Addition Program (TI-58/59-HP41C) calculators

OR

2. Solve graphically by placing 4 individual vector segments sequentially head to tail. (See manual for detailed instructions).

Velocity Determination

Refer to your calibration curve of readout versus preferred units of flow (e.g. feet per day).

Direction:	Velocity:

Form 104 available from your local K-V Associates, Inc. dealer.

CALIBRATION CURVE MODEL: 40 L

SERIAL NO:

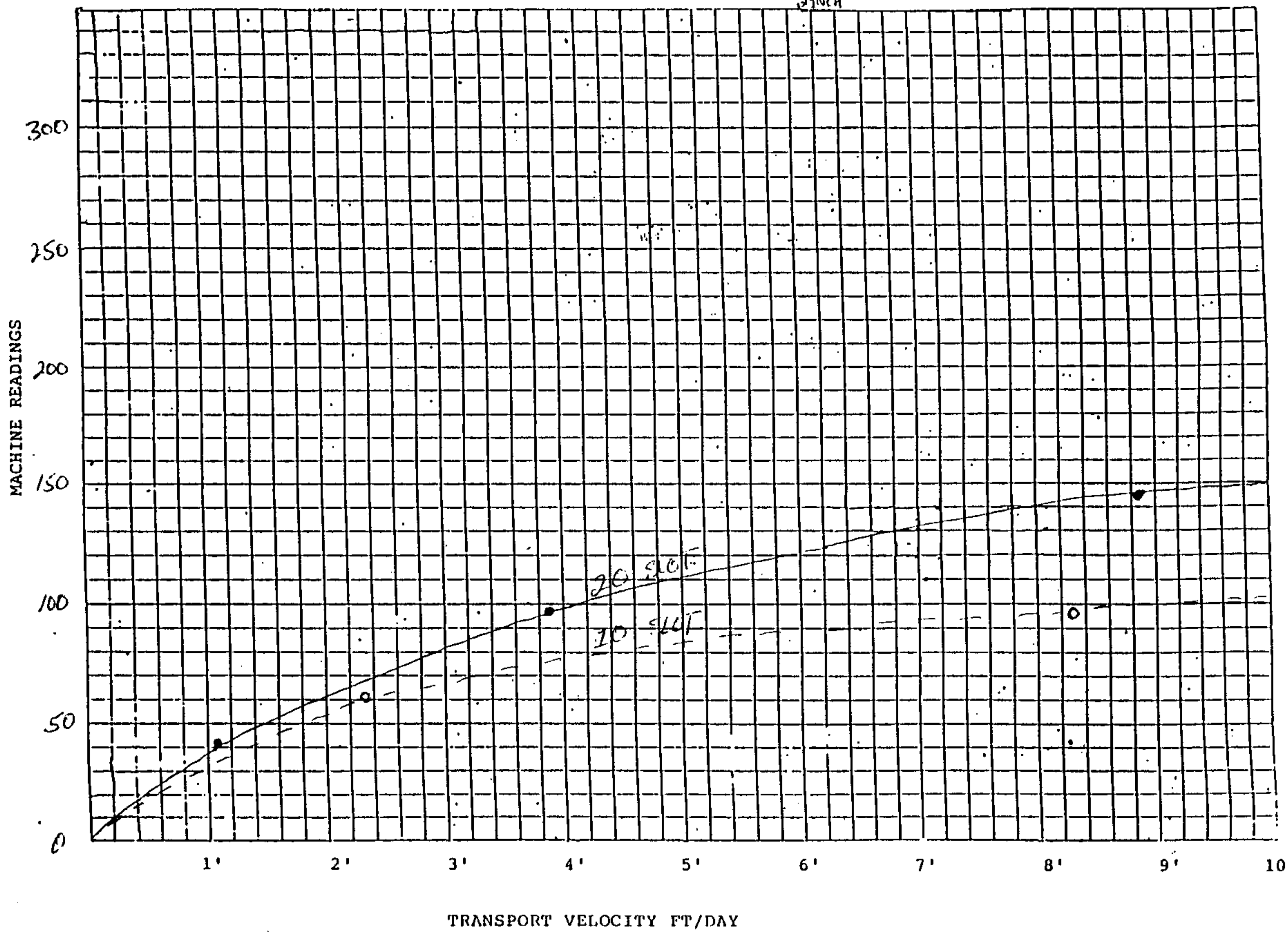
SPAN SWITCH @ 4 x

READ @

WELL SCREEN: BK.

PACKER TYPE: Fuzzy Inch

	20 SLOT				10 SLO.	
	8.76 ft/d	144.5	READING #1	@	17.5 ft/d	251 / 288.5
	3.89 ft/d	95	READING #2	@	8.3 ft/d	92
	1.07 ft/d	41.5	READING #3	@	2.35 ft/d	67



PUERTO RICAN OIL LABORATORY

INSPECTION DATA OF PETROLEUM FUELS

LABORATORY ANALYSIS

FAX(809)836-1859 TEL (809)843-3030 EXT. 233

PROLAB

SAMPLE REF. NO.:
PRODUCT: HYDROCARBON
SOURCE: CORCO WELLS
ACCOUNT: CORCO
INSPECTOR: PETE DOTSEY (DMS)

DATE: 08/14/95

SAMPLE DATE: TIME: METHOD ASTM	TEST	08/09/95 1725 AV 501B	08/08/95 1000 PD # 4	08/08/95 1420 PD # 10	08/09/95 1750 PD # 15	08/09/95 1420 PD # 26
D 287 92	GRAV. API @ 60°F	52.0	31.7	43.5	43.0	45.1
D 445	VISC. KIN. CST @ 50°F	0.64	3.23	0.72	0.66	0.86

QUIMICO LICENCIADO • Estado Libre Asociado de P.R. • RAUL SANTOS Lic. # 3079

CERTIFIED BY Raul Santos
CHEMIST

CHAIN OF CUSTODY RECORD
ENVIROLABS, INC.

NAME OF CLIENT & POSTAL ADDRESS: DSM ENV. SERV. INC
1880 S. Kirkwood Suite 2014 Houston TX 77077

TEL.

SAMPLE COLLECTED BY: Pete Dotsey of DSM

SAMPLE NO.	DATE	TIME	ENVIROLABS NO.	SAMPLE IDENTIFICATION	CONDUCTIVITY				REMARKS
PD-4	8/8/95	1000		Product GAS/DIESEL	X				Resultados para el lunes
PD-10	8/8/95	1420		PRODUCT GAS BLEND	X				8/21/95
PD-15	8/9/95	1750		PRODUCT GAS BLEND	X				
PD-26	8/9/95	1600		PRODUCT GAS BLEND	X				
MIS-	8/9/95	1725		PRODUCT GAS BLEND	X				MIS AREA TANK 501B
PD-27	8/17/95	1215		PRODUCT GAS BLEND	X				
									Report Results to
									Pete Dotsey - DSM

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
Pete Dotsey	8/17/95	1420	Carmen N. Ruiz				

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:

RELINQUISHED BY:	DATE	TIME	RECEIVED FOR LAB BY:	DATE	TIME	SAMPLING WITNESSED BY:
Carmen N. Ruiz	8/17/95	2:20 pm	Carmen I López	8/17/95		

CORE LABORATORIES

DSM ENVIRONMENTAL SERVICES INC.
CORCO PHASE 2 - STEP 1
FINAL REPORT

CORE LABORATORIES FILE NO. 57151-18368

CORELAB

PETROLEUM SERVICES

January 3, 1996

DSM Environmental Services
1830 South Kirkwood Suite 201A
Houston, TX 77077
Attn: Mr. Pete Dotsey

Re: Core Analysis Report
CORCO Phase 2 - Step 1
CL File No. 57151-18368

Dear Mr. Dotsey:

Eleven samples for plug analysis were delivered to Core Laboratories' Hollister Road facility in Houston, Texas. Analysis was performed as directed by DSM Environmental representatives.

The following documentation includes: procedures for petrophysical measurements; a list of Houston laboratory personnel involved in this project; and the resultant data reported in tabular format. The type of equipment used in each procedure is also specified.

Samples are currently stored at Core Laboratories' Hollister Road laboratory in Houston. Please let us know where to ship them for permanent storage. We will store them for six months, after which time they will be destroyed.

We appreciate this opportunity to be of service. If we can be of further assistance, please do not hesitate to call.

Sincerely,

CORE LABORATORIES

Michael R. Long
Laboratory Supervisor

TABLE OF CONTENTS

SAMPLE PREPARATION

PLUG DRILLING and TRIMMING: Plug samples were taken out of each of the samples sent by DSM Environmental. The 1.0 inch diameter plugs were drilled using water as the drilling lubricant/coolant. The plugs were faced with a diamond facing tool to provide right circular cylinders.

PETROPHYSICAL MEASUREMENTS

DEAN STARK ANALYSIS: Each sample was weighed, placed in a glass tare, and extracted of hydrocarbons and water using a Dean Stark apparatus. The Dean Stark method uses toluene as the refluxing solvent. Each sample was suspended over boiling toluene at approximately 240 degrees. Toluene vapor, along with water vapor from each sample, was cooled in a distillation tower and collected in a receiving tube where the water separated from the toluene. The extracted oil remained in the toluene. Saturations were calculated by using the measured water volume and a gravimetrically derived oil volume. The helium porosities were used to obtain pore volumes.

PLUG DRYING: All samples were dried in a convection oven at 240 degrees F. until weight stabilization was achieved.

GRAIN VOLUME: Direct grain volume measurements were made using a small volume porosimeter (SVP). This instrument utilizes the principle of gas expansion as described by Boyle's law. Helium was used as the test gas. The instrument was calibrated daily and test standards were run to verify instrument accuracy.

GRAIN DENSITY: Calculated grain densities were obtained utilizing direct grain volume measurements and sample weights. Grain densities were checked against lithology standards.

PLUG DIMENSIONS: Sample lengths and diameters were measured using digital metric calipers.

CMS-300 ANALYSIS:

A. PERMEABILITY "k": Permeability was measured by flowing helium from a reference cell through the core. The size of the reference cell used is optimized during a pre-measurement flow through test. The chambers available are approximately 2, 9, 56 and 315 cc's. The actual size of each cell is calculated during calibration procedures. The cell combination used varies with each sample. The downstream end of the core was maintained at atmospheric pressure. The upstream pressure was initially at 240 psig and was allowed to decay through the sample. The pressure decay vs. time was monitored and recorded digitally. The difference between the confining stress and the mean pore pressure during flow is the net confining stress.

    a. K-air: Permeability to air at the net confining stress was calculated from pressure decay/time data.

    b. K-Klinkenberg: Unsteady state equations were used with pressure decay/time data to calculate the Klinkenberg slip corrected permeability at the net confining stress.

B. POROSITY: Pore volume was determined by expansion of helium into the core sample from a known volume source at approximately 240 psig. At pressure equilibrium, Boyle's Law was used to compute pore volume. Porosity was then calculated by using the pore volume from the CMS-300 and the grain volume from the Small Volume Porosimeter.

CORELAB

CORE LABORATORIES

Company : DSM Environmental Services Inc.
Well : CORCO Phase 2 - Step 1
Field
County

CL File No : 57151-18368
Date : 14-Nov-1995
Analysts : ML/JW/AC/DS

DEAN STARK ANALYSIS

Sample Number	Depth	Porosity	Kl	Kair	Saturation		Grain Density	Description
					Oil	Water		
	ft	%	md	md	% Pore Volume		g/cm3	
					PT-2			
1	141.00	22.8	***	*	6.4	77.9	2.72	Ls wh spts gld fluor
2	160.00	22.6	1.250	1.840	0.0	90.3	2.71	Ls wh no fluor
					PT-3			
3	33.00	27.3	621.600	638.400	6.3	57.3	2.71	Ls wh spts gld fluor
4	38.00	24.6	235.900	385.200	4.0	58.1	2.72	Ls wh spts gld fluor
5	45.00	23.5	5.259	7.209	0.0	84.0	2.71	Ls wh no fluor
					PT-5			
6	19.00	12.6	3.171	3.448	1.3	27.3	2.72	Ls wh spts gld fluor
7	28.00	13.3	10.200	12.320	0.0	81.7	2.71	Ls wh/tn no fluor
8	29.00	21.6	37.060	44.160	0.1	71.9	2.70	Ls wh/tn no fluor
9	31.00	11.9	0.768	1.117	0.0	72.5	2.70	Ls wh no fluor
10	38.00	13.5	0.578	0.646	0.5	86.0	2.71	Ls wh no fluor
11	49.00	13.8	164.400	257.400	0.8	67.2	2.71	cgl Ls wh/gry no fluor

* Sample 1 not suitable for permeability measurement.

APPENDIX A: LIST OF PROJECT ANALYSTS and PERSONNEL

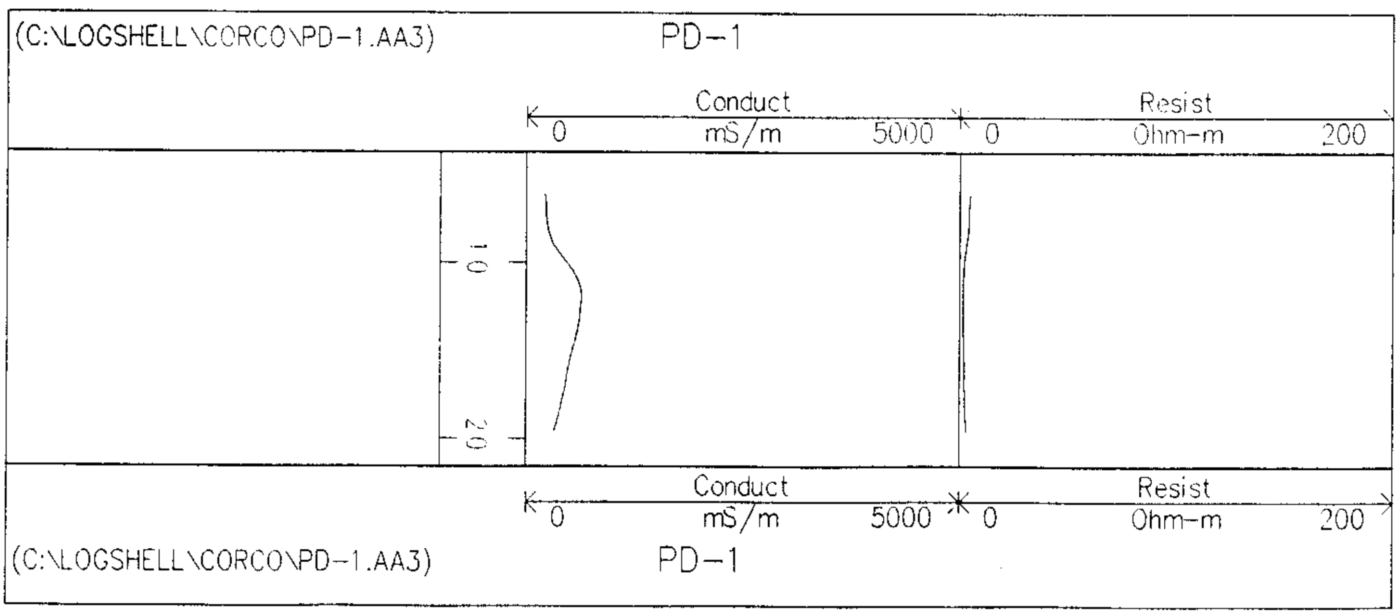
PETROLEUM SERVICES MANAGER . . . . FEDERICA M. CURBY
LABORATORY SUPERVISOR . . . . MICHAEL R. LONG
SENIOR PROJECT ANALYST . . . . JOSEPH A. WEIR
SENIOR PROJECT ANALYST . . . . ARTHUR CURBY
ANALYST . . . . DAVE STELLER
TECHNICAL SALES REPRESENTATIVE . . . . TOM SWISHER
SECRETARIAL . . . . JANET PUFFER

APPENDIX B: REPORT DISTRIBUTION

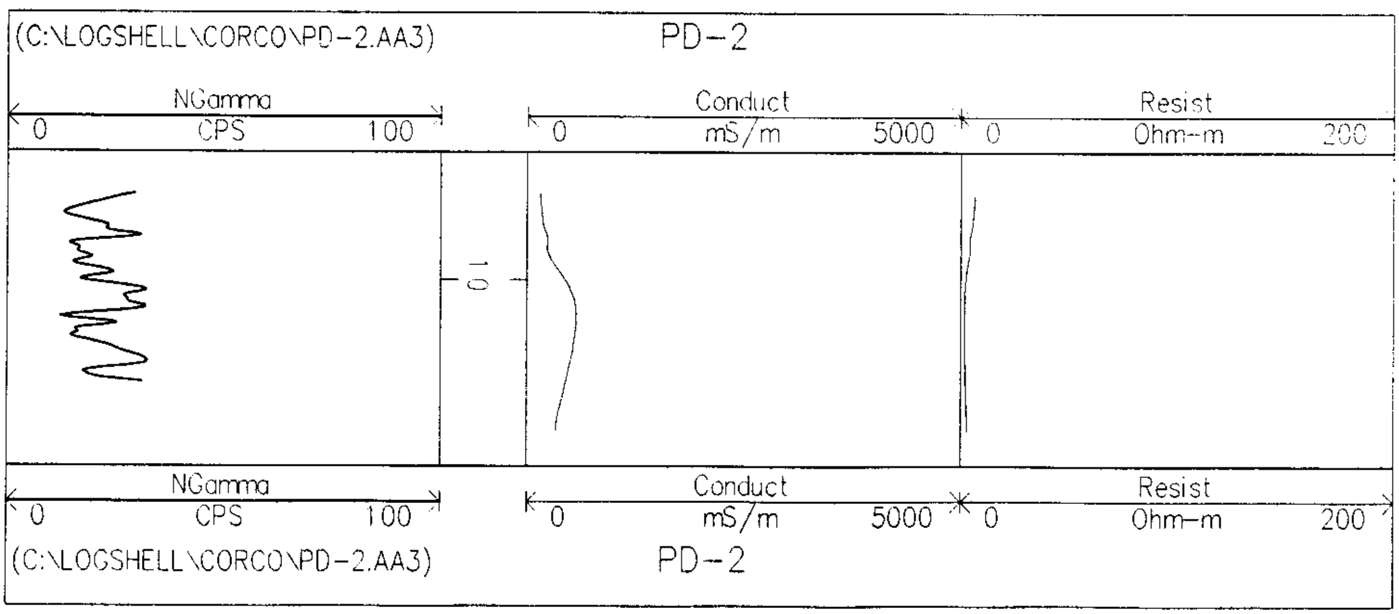
DSM ENVIRONMENTAL SERVICES INC.
CORCO PHASE 2 - STEP 1
FINAL REPORT
CORE LABORATORIES FILE NO. 57151-18368

DSM Environmental Services (3 cc)
1830 South Kirkwood Suite 201A
Houston, TX 77077
Attn: Mr. Pete Dotsey

APPENDIX F-1
GRAPHICAL WELL LOG TRACES



(C:\LOGSHELL\CORCO\PD-1.AA3)
PD-1
Conduct
0
mS/m
5000
Resist
0
Ohm-m
200
10
20
Conduct
0
mS/m
5000
Resist
0
Ohm-m
200
(C:\LOGSHELL\CORCO\PD-1.AA3)
PD-1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PD-2
NGamma
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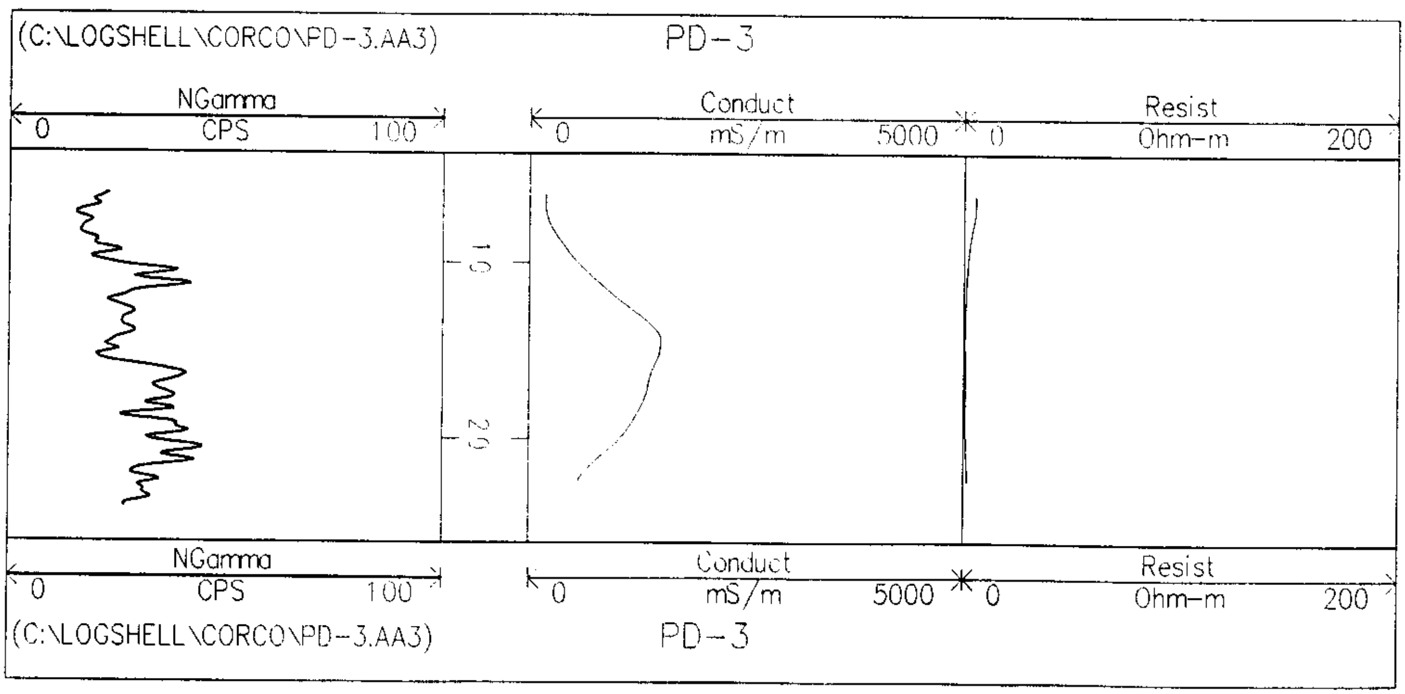
CPS
100
Conduct
0
mS/m
5000
Resist
0
Ohm-m
200
10
NGamma
0
CPS
100
Conduct
0
mS/m
5000
Resist
0
Ohm-m
200
(C:\LOGSHELL\CORCO\PD-2.AA3)
PD-2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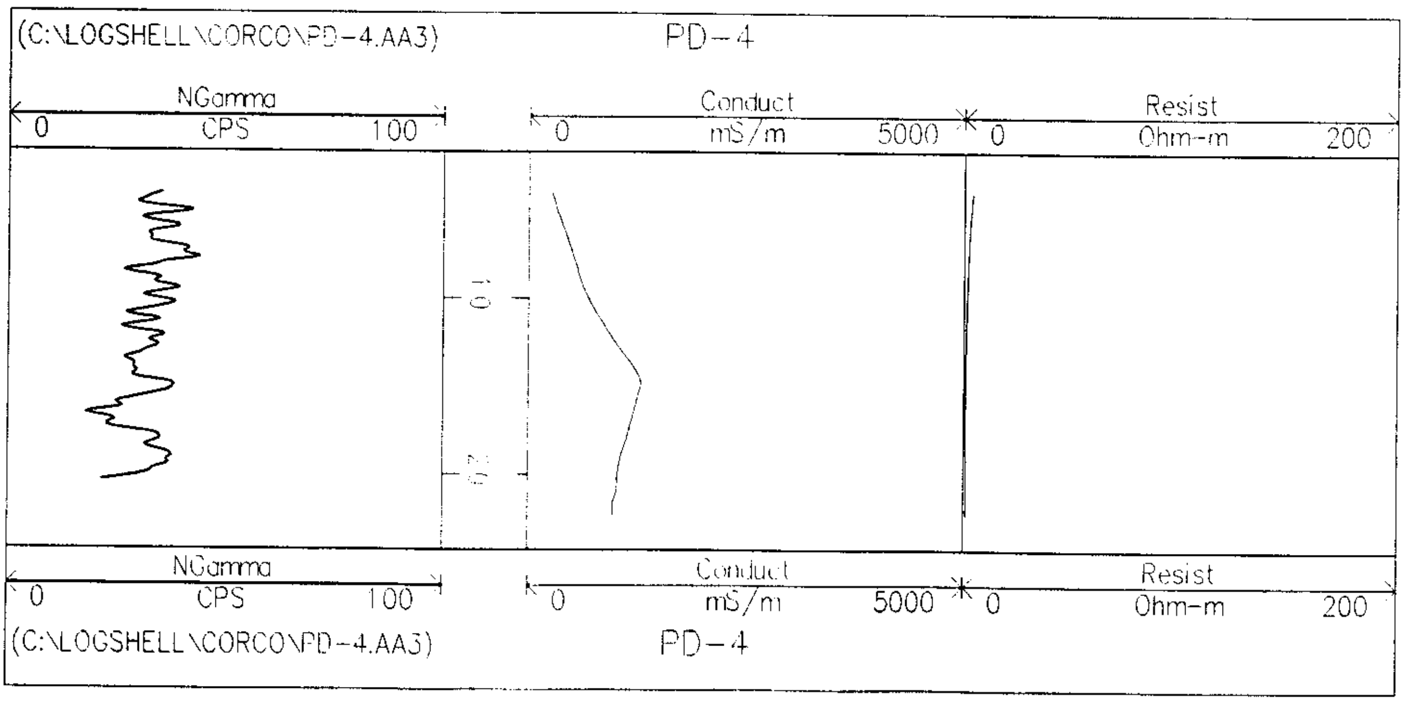
NGamma
0
CPS
100
Conduct
0
mS/m
5000
Resist
0
Ohm-m
200
10
20
NGamma
0
CPS
100
Conduct
0
mS/m
5000
Resist
0
Ohm-m
200
(C:\LOGSHELL\CORCO\PD-3.AA3)
PD-3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PD-4
NGamma
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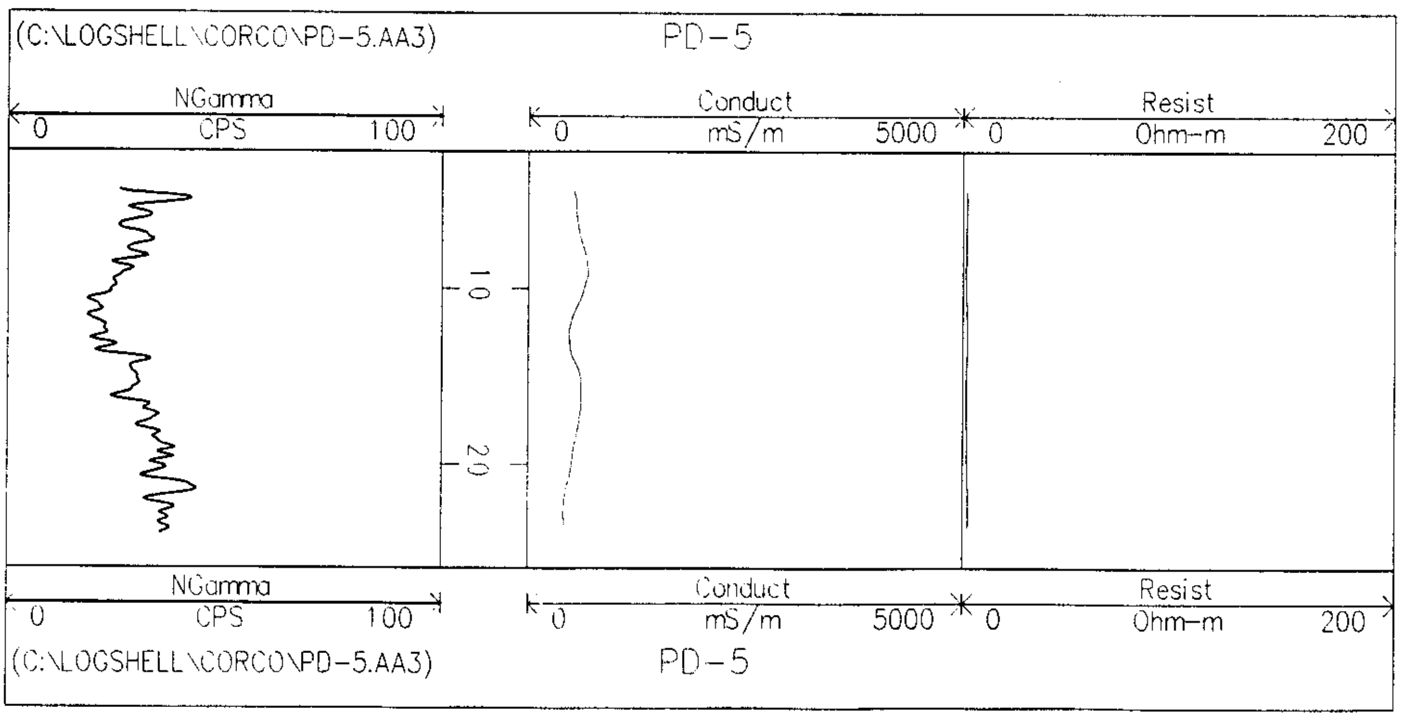
CPS
100
Conduct
0
mS/m
5000
Resist
0
Ohm-m
200
10
20
NGamma
0
CPS
100
Conduct
0
mS/m
5000
Resist
0
Ohm-m
200
(C:\LOGSHELL\CORCO\PD-4.AA3)
PD-4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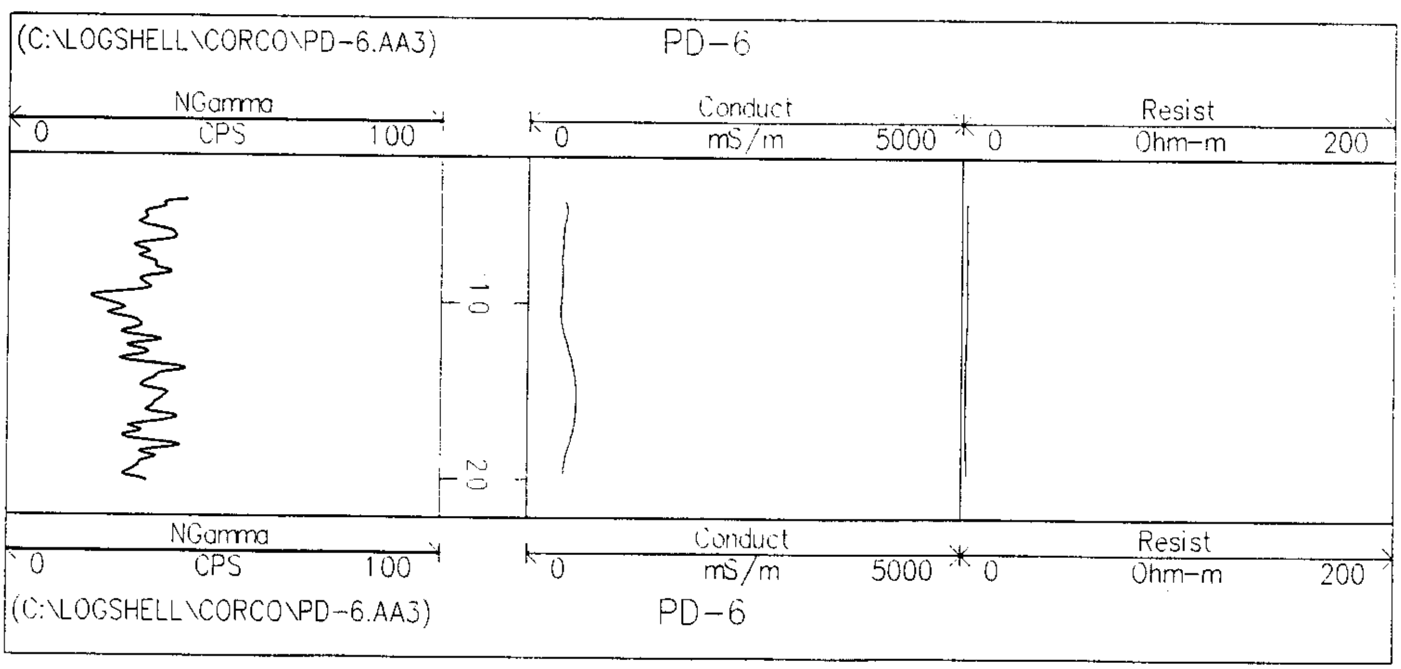
PD-5
NGamma
0 CPS 100
Conduct
0 mS/m 5000
Resist
0 Ohm-m 200
10
20
NGamma
0 CPS 100
Conduct
0 mS/m 5000
Resist
0 Ohm-m 200
(C:\LOGSHELL\CORCO\PD-5.AA3)
PD-5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PD-6
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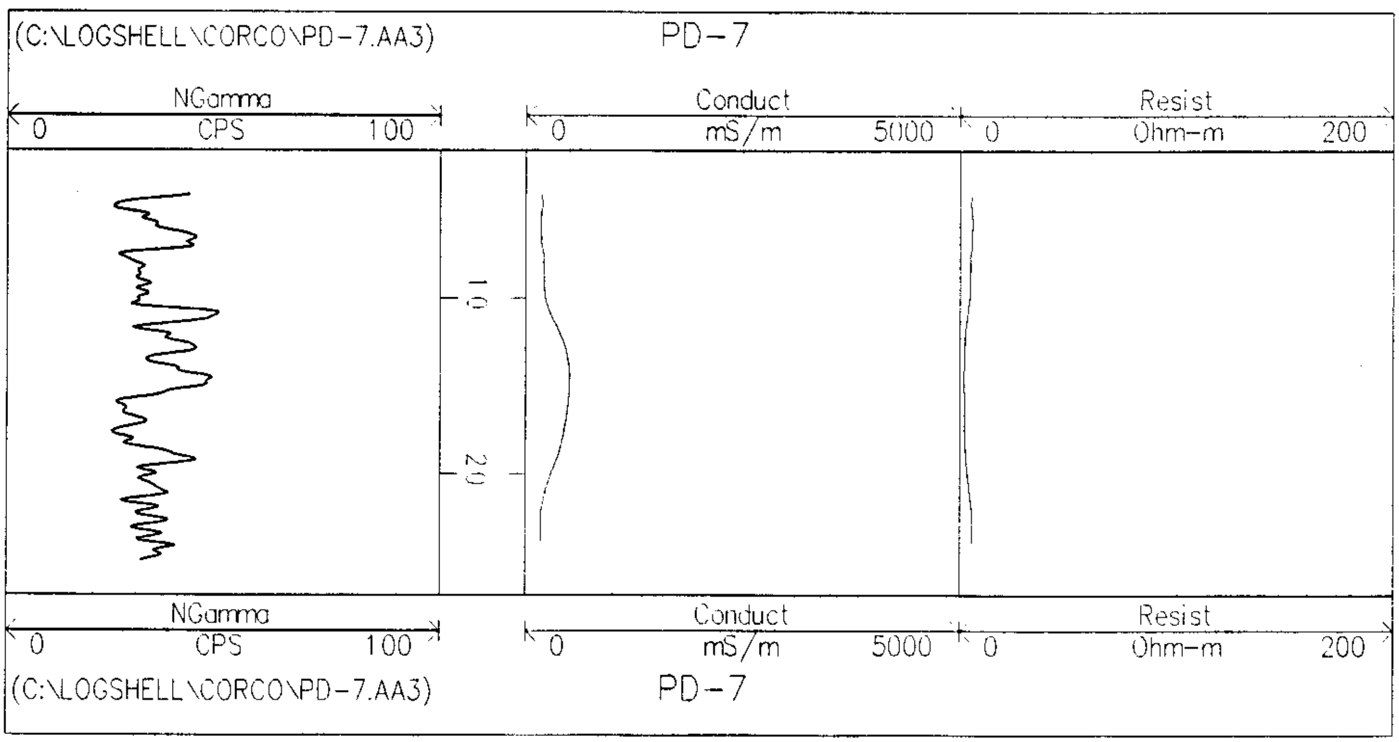
CPS
100
Conduct
0
mS/m
5000
Resist
0
Ohm-m
200
10
20
NGamma
0
CPS
100
Conduct
0
mS/m
5000
Resist
0
Ohm-m
200
(C:\LOGSHELL\CORCO\PD-6.AA3)
PD-6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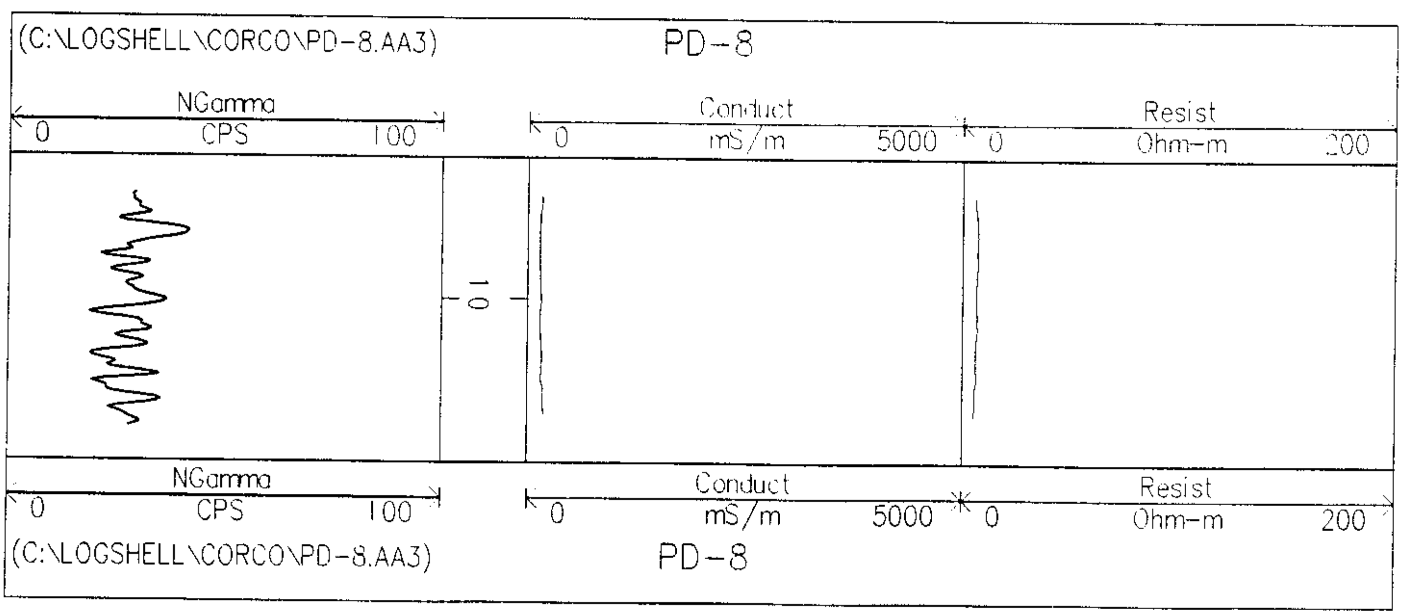
CPS
100
Conduct
0
mS/m
5000
Resist
0
Ohm-m
200
10
20
NGamma
0
CPS
100
Conduct
0
mS/m
5000
Resist
0
Ohm-m
200
(C:\LOGSHELL\CORCO\PD-7.AA3)
PD-7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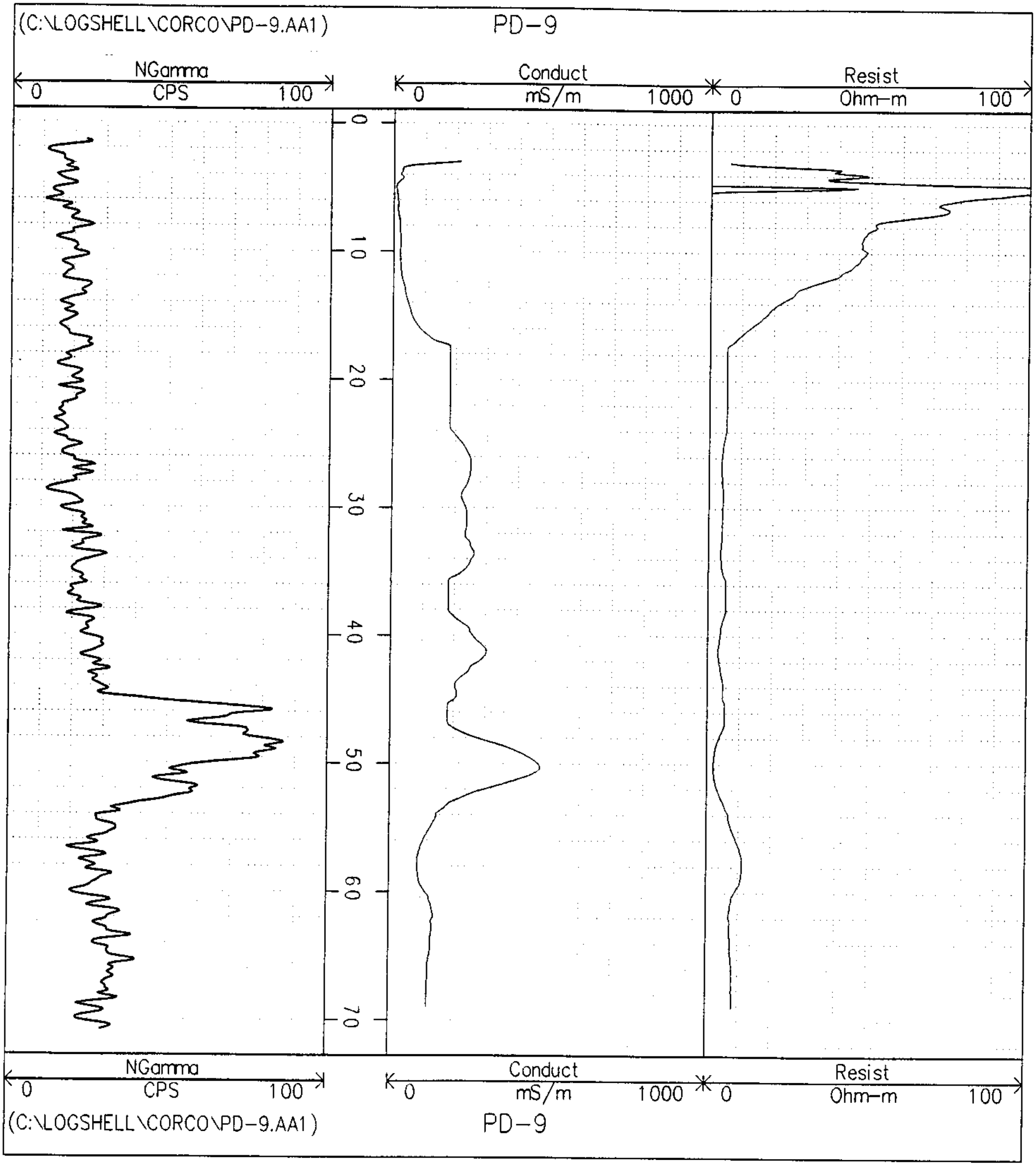
PD-8
NGamma
0 CPS 100
Conduct
0 mS/m 5000
Resist
0 Ohm-m 200
10
NGamma
0 CPS 100
Conduct
0 mS/m 5000
Resist
0 Ohm-m 200
(C:\LOGSHELL\CORCO\PD-8.AA3)
PD-8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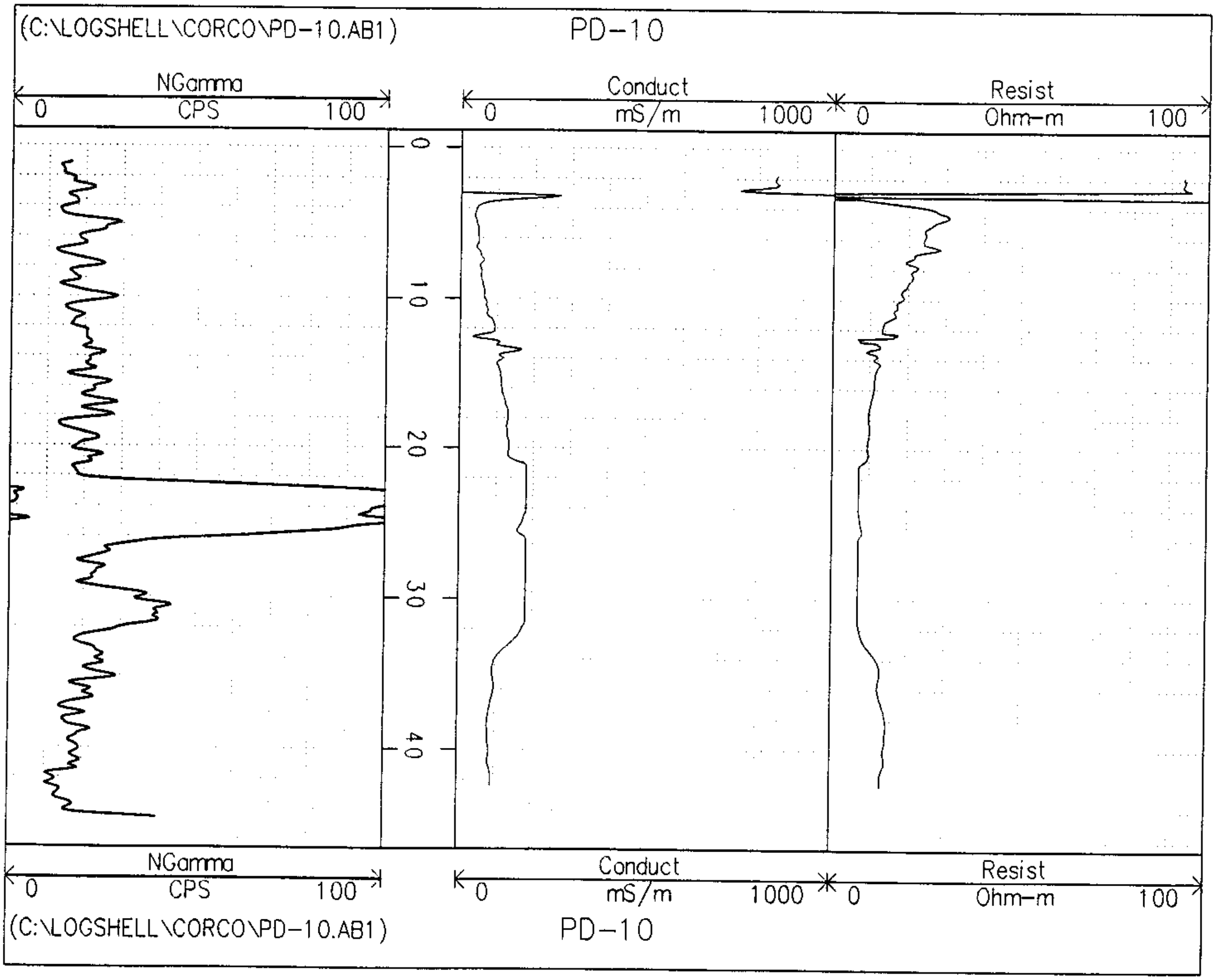
PD-9
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
0
10
20
30
40
50
60
70
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-9.AA1)
PD-9



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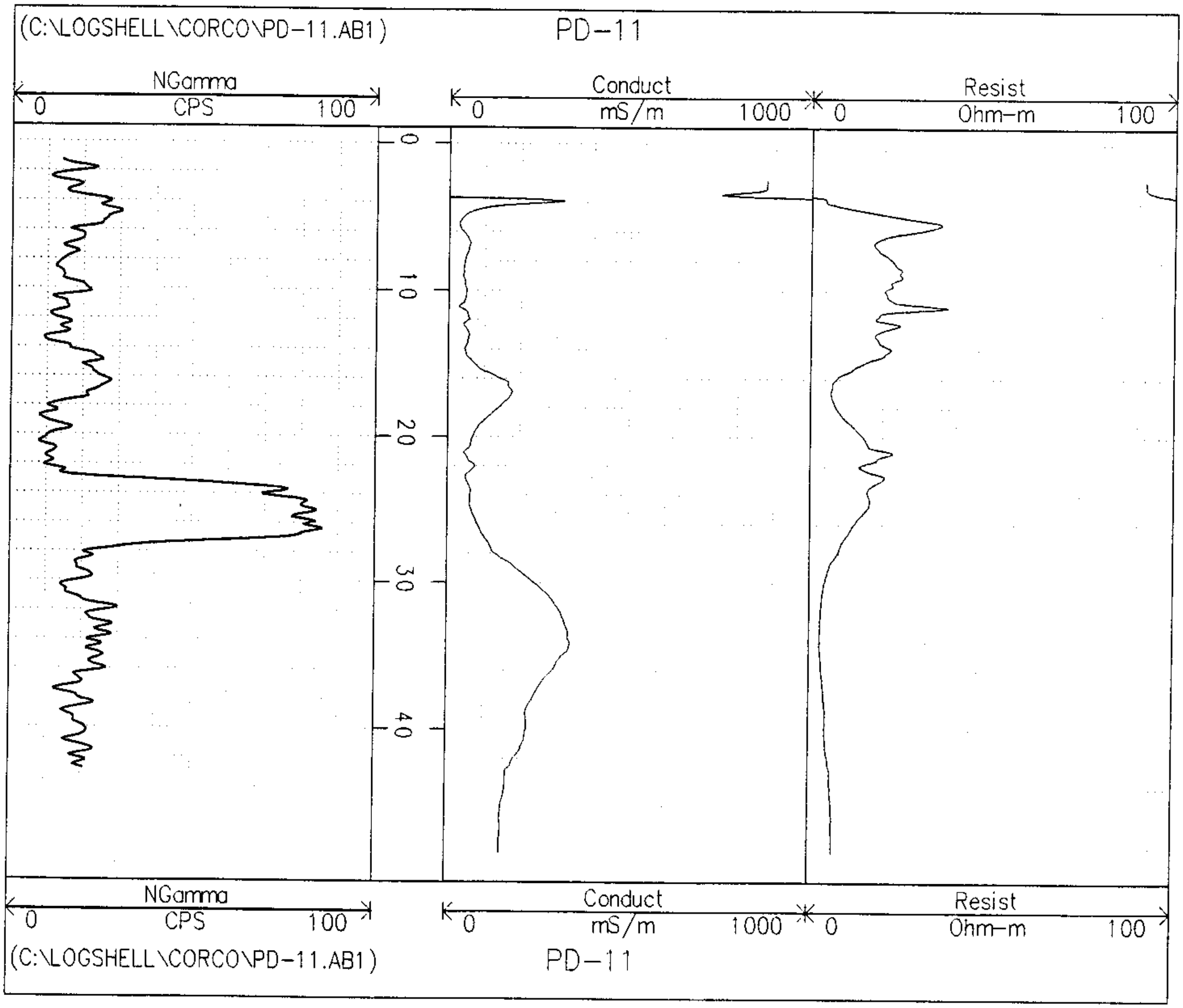
PD-10
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
0
10
20
30
40
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-10.AB1)
PD-10



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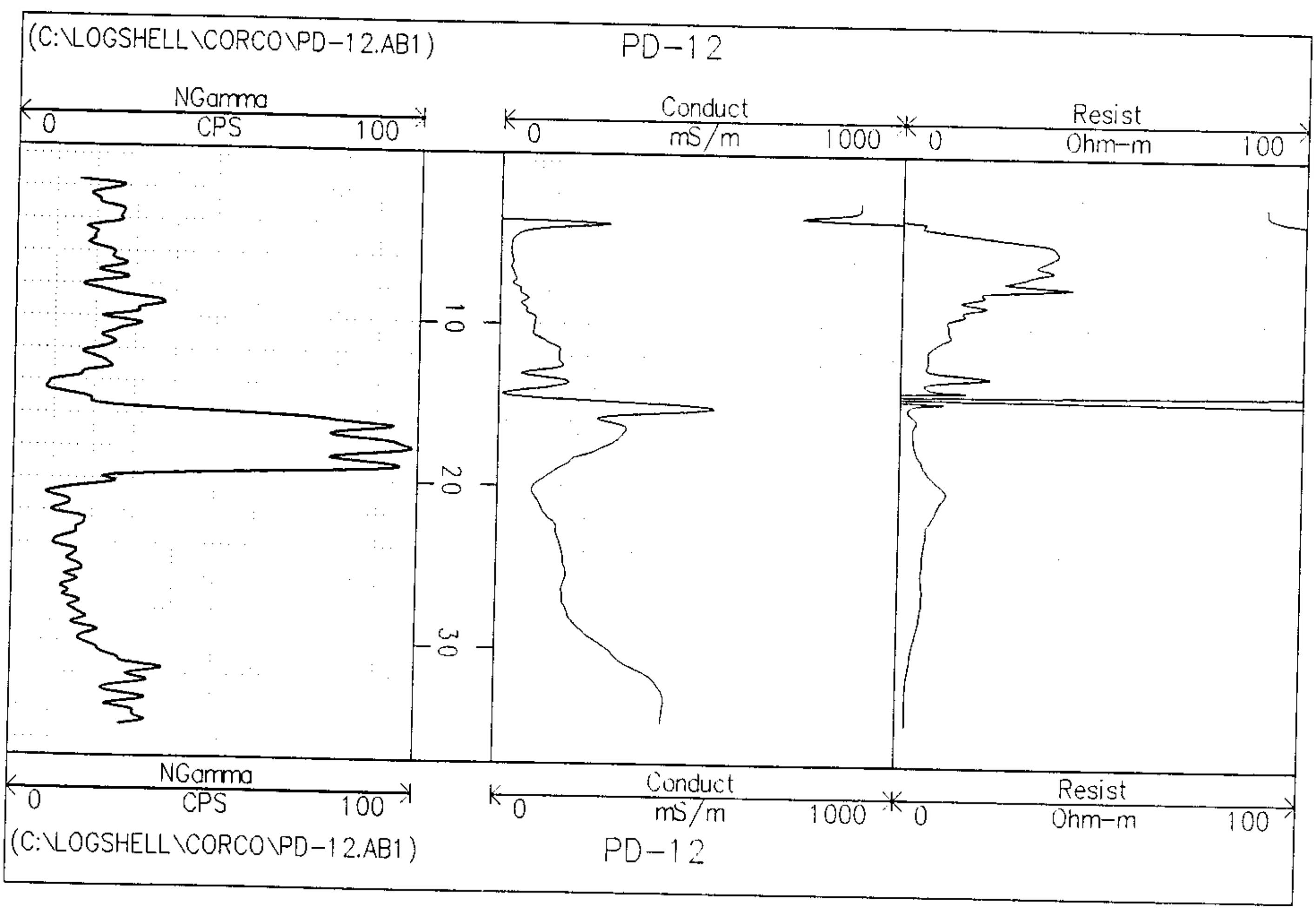
PD-11
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
0
10
20
30
40
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-11.AB1)
PD-11



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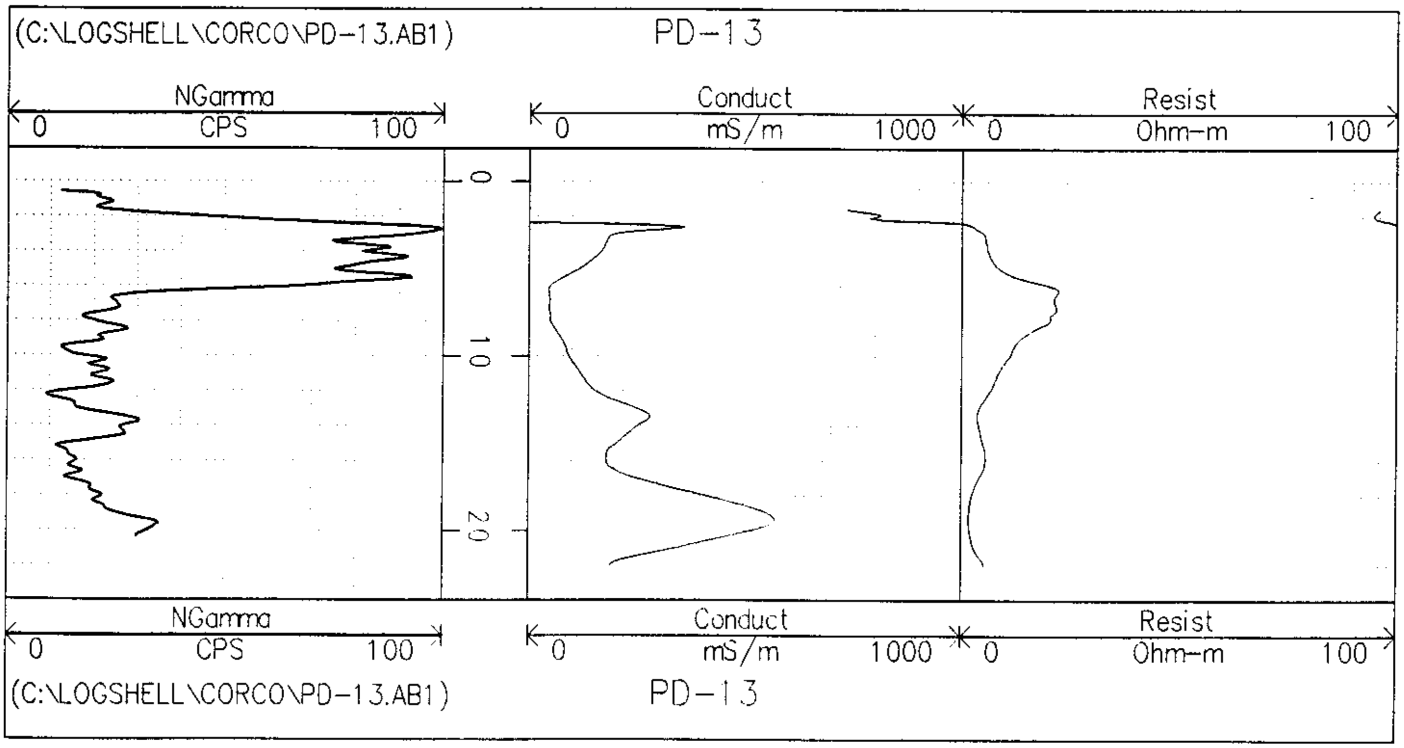
PD-12
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
10
20
30
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-12.AB1)
PD-12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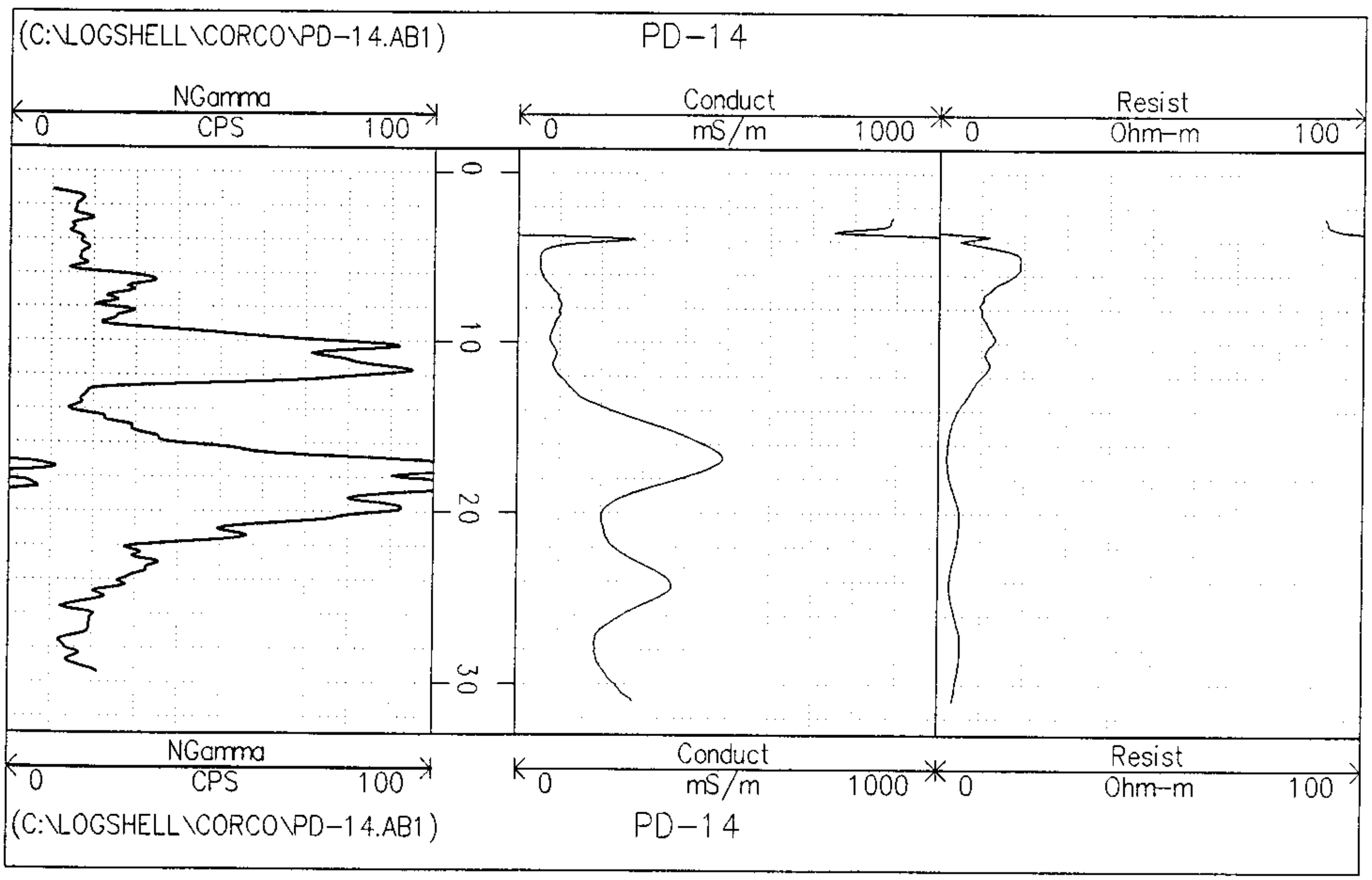
PD-13
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
0
10
20
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
(C:\LOGSHELL\CORCO\PD-13.AB1)
PD-13



(C:\LOGSHELL\CORCO\PD-14.AB1)
PD-14
NGamma
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Conduct
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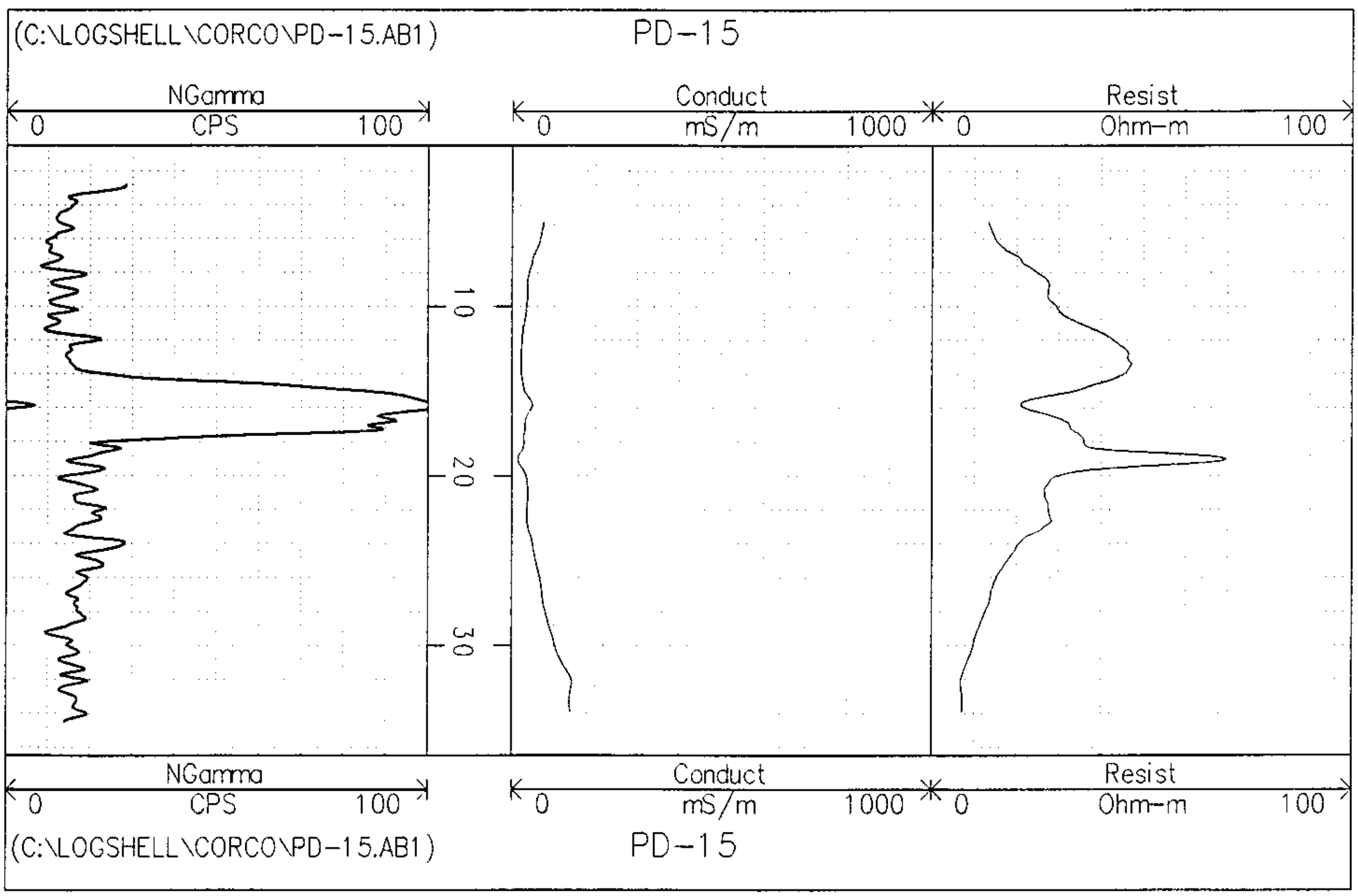
Resist
0 Ohm-m 100
0
10
20
30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PD-15
NGamma
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Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
10
20
30
NGamma
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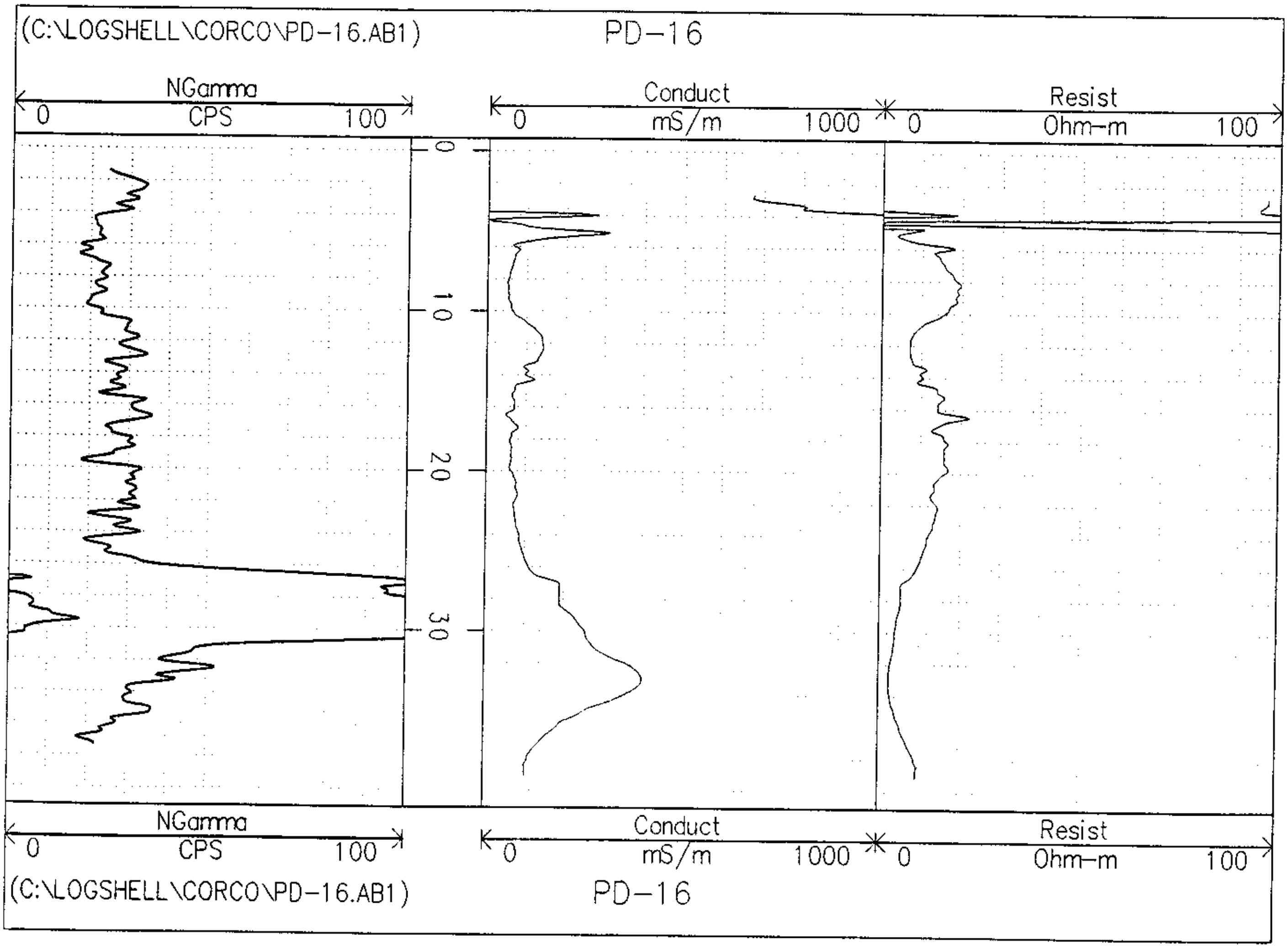
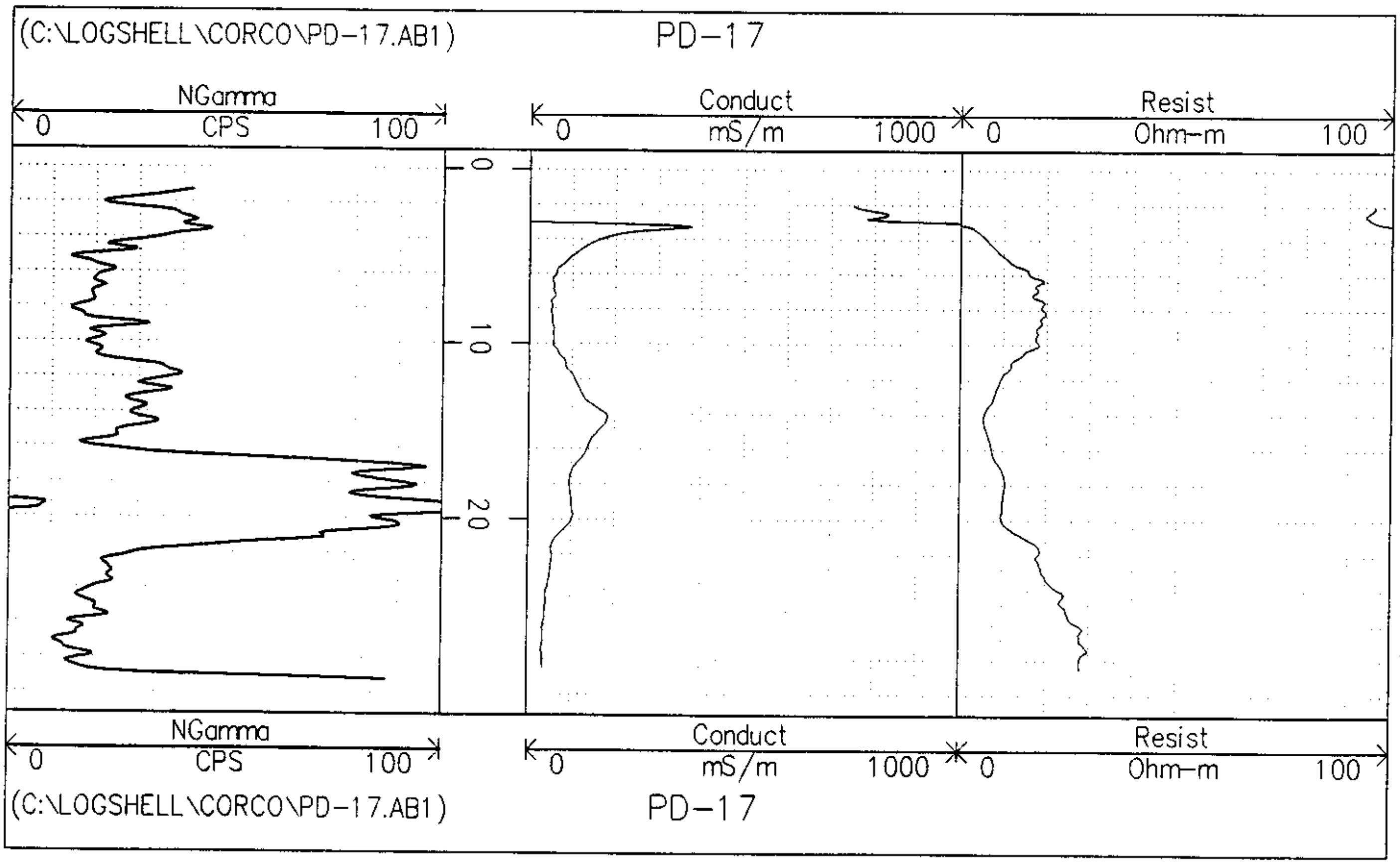
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
(C:\LOGSHELL\CORCO\PD-15.AB1)
PD-15


(C:\LOGSHELL\CORCO\PD-16.AB1)
PD-16
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
0
10
20
30
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-16.AB1)
PD-16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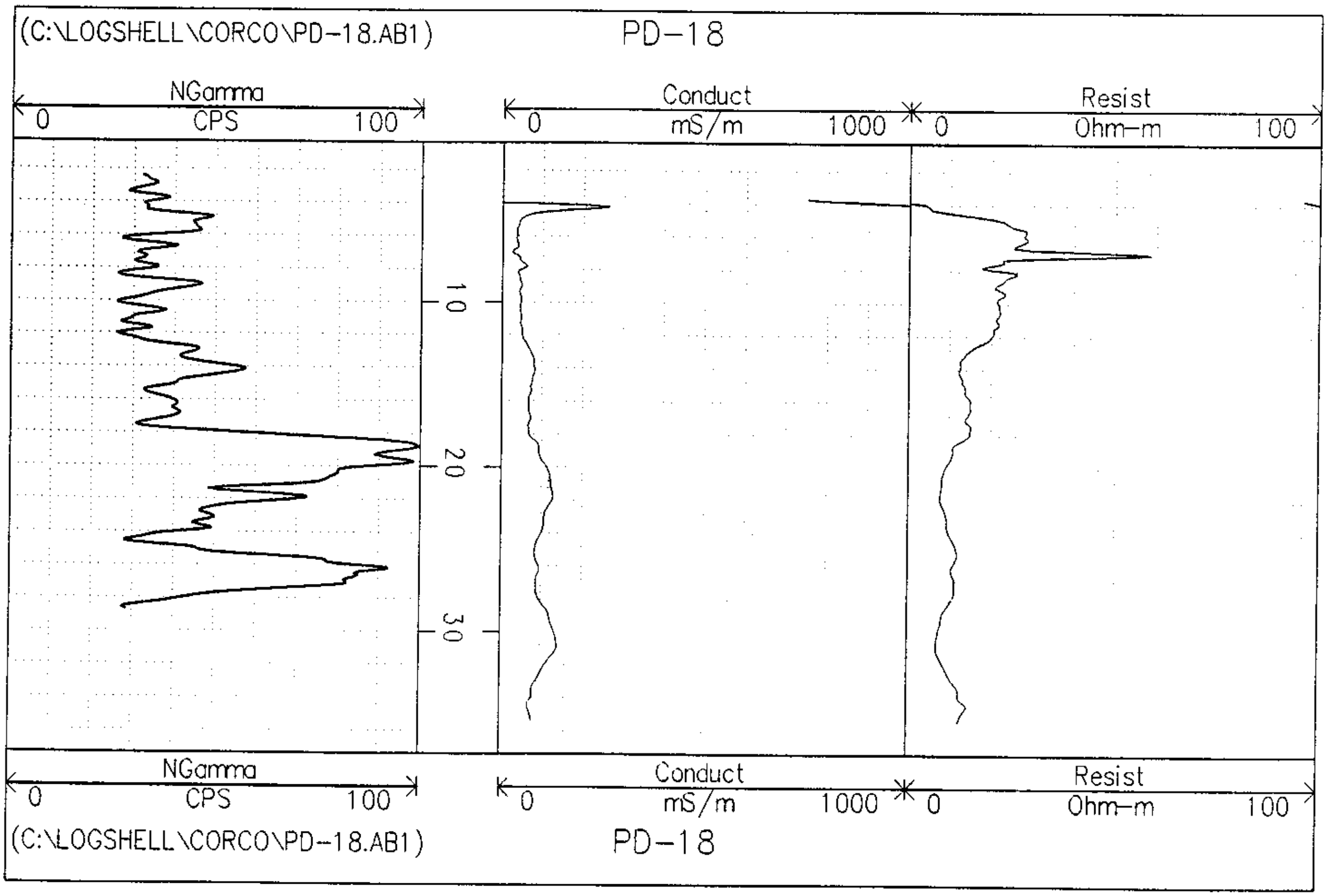
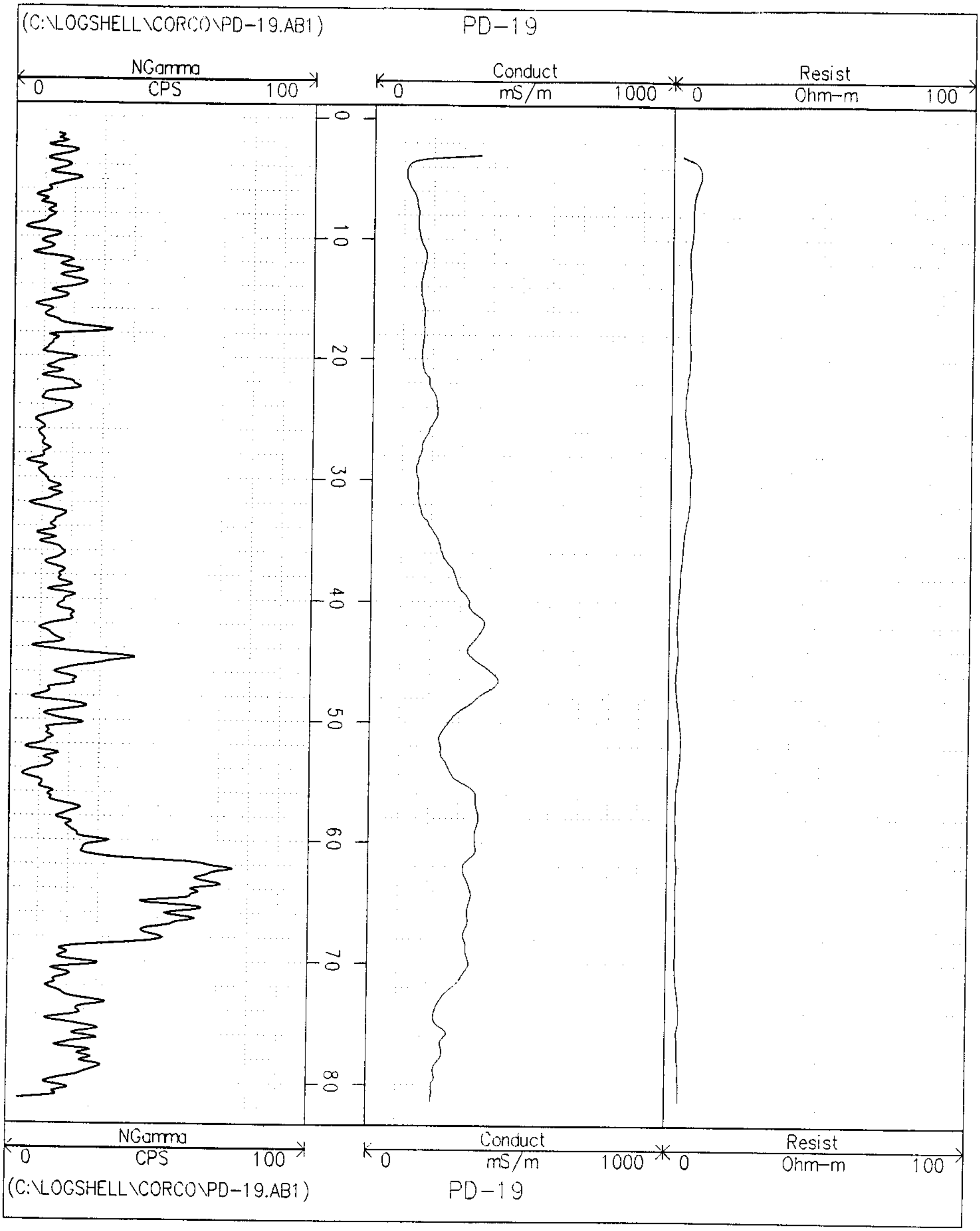
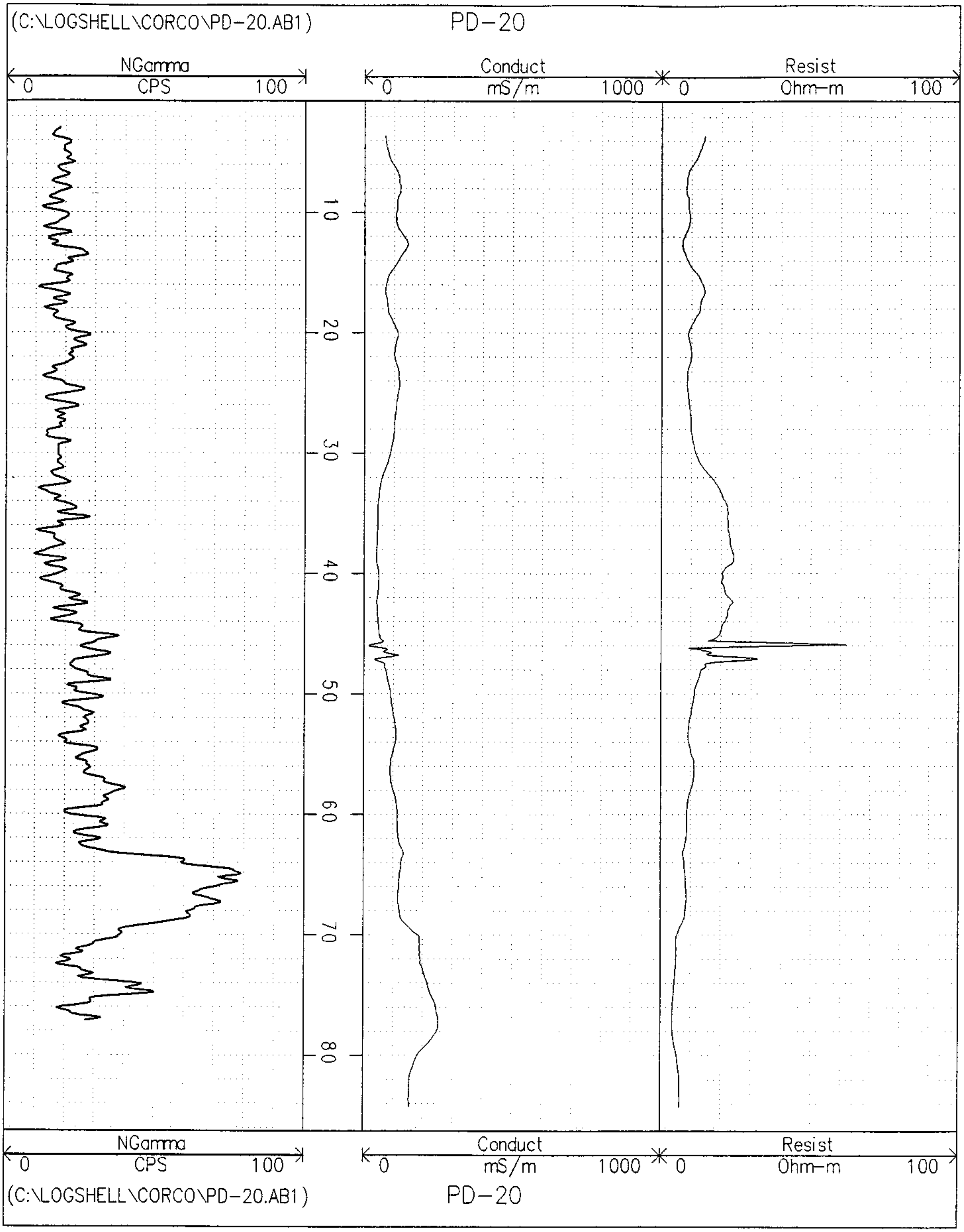
PD-17
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
0
10
20
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-17.AB1)
PD-17



(C:\LOGSHELL\CORCO\PD-18.AB1)
PD-18
NGamma
CPS
0
100
Conduct
mS/m
0
1000
Resist
Ohm-m
0
100
10
20
30
NGamma
CPS
0
100
Conduct
mS/m
0
1000
Resist
Ohm-m
0
100
(C:\LOGSHELL\CORCO\PD-18.AB1)
PD-18



(C:\LOGSHELL\CORCO\PD-19.AB1)
PD-19
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
0
10
20
30
40
50
60
70
80
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-19.AB1)
PD-19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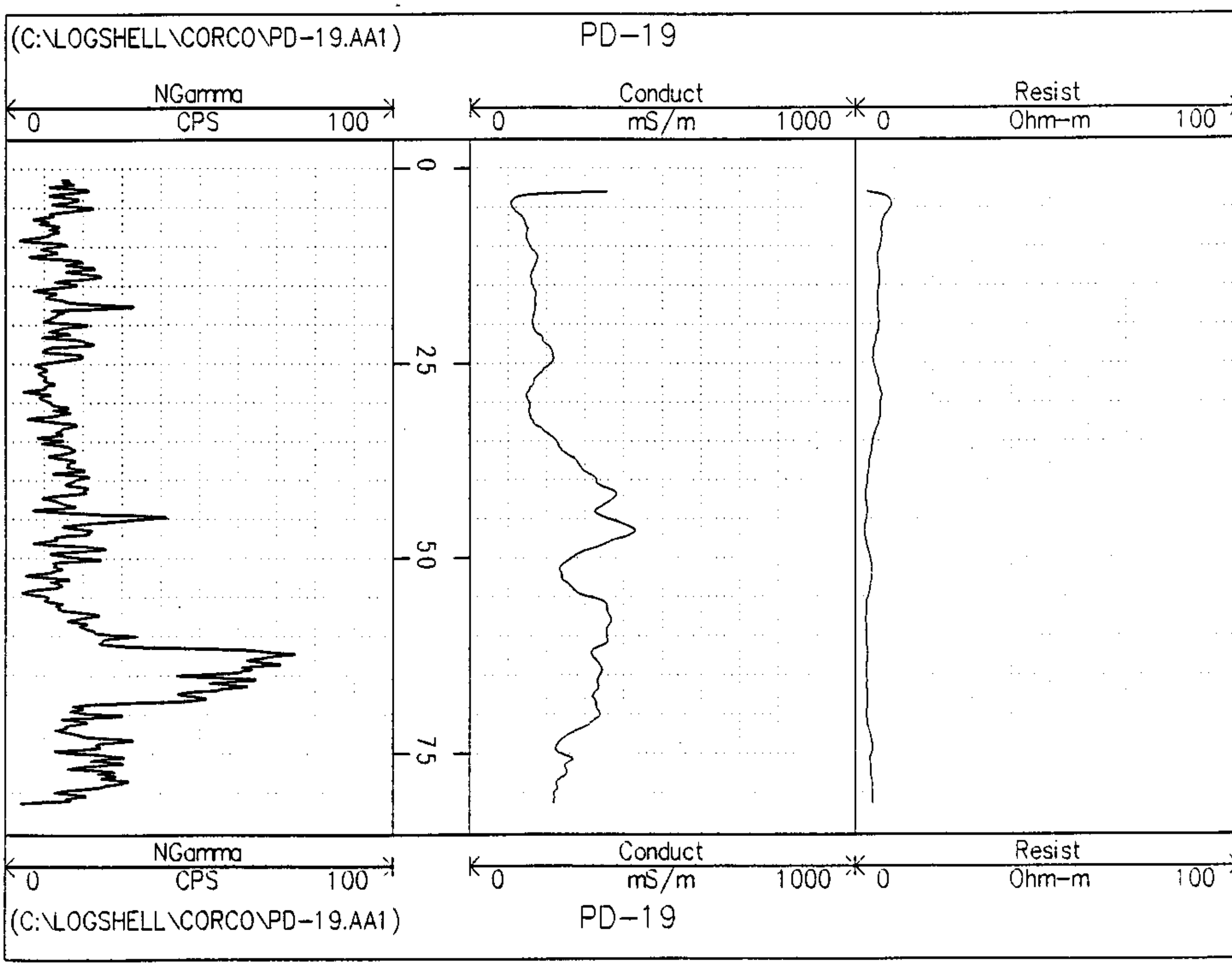
PD-20
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
10
20
30
40
50
60
70
80
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
(C:\LOGSHELL\CORCO\PD-20.AB1)
PD-20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PD-19
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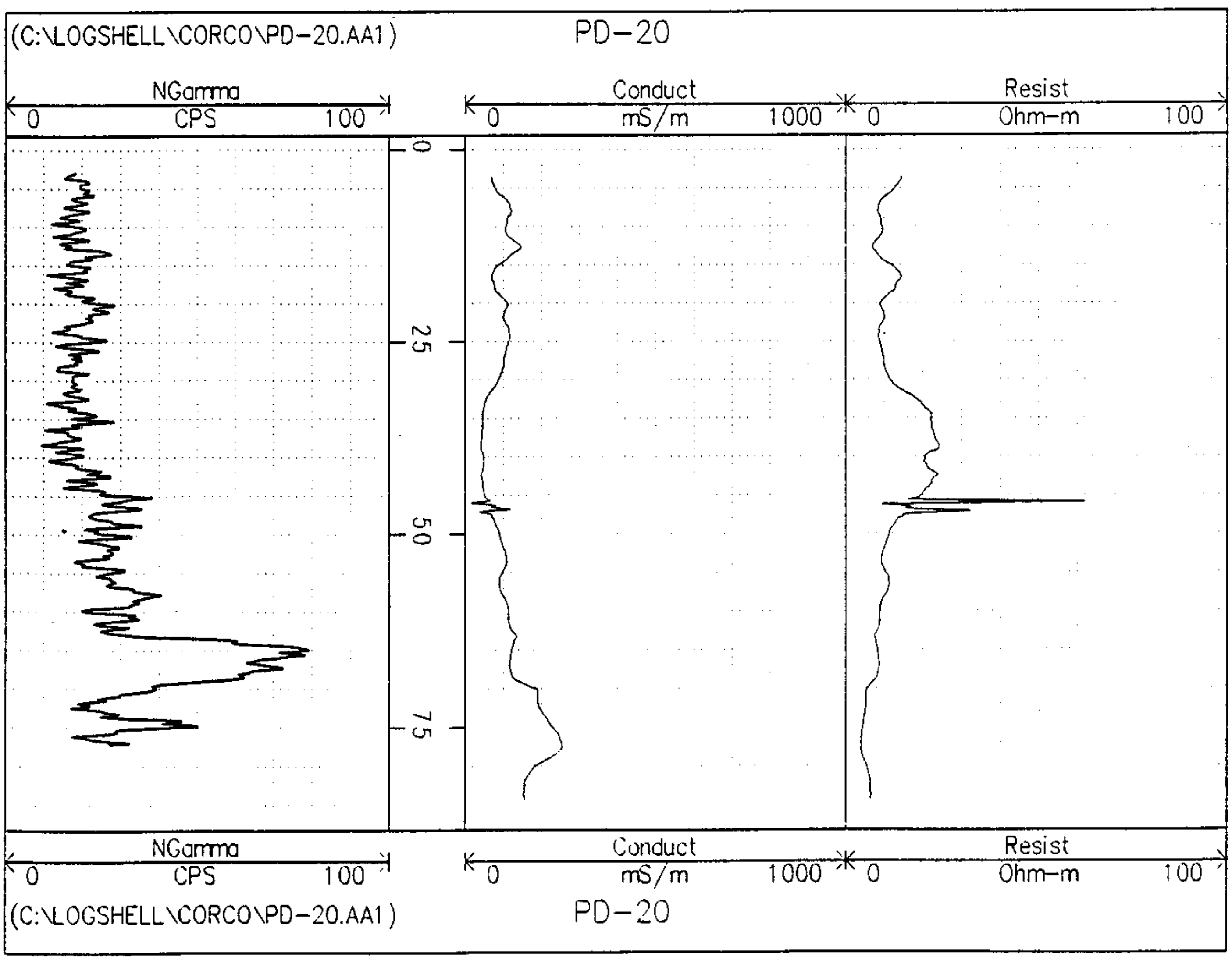
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
0
25
50
75
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-19.AA1)
PD-19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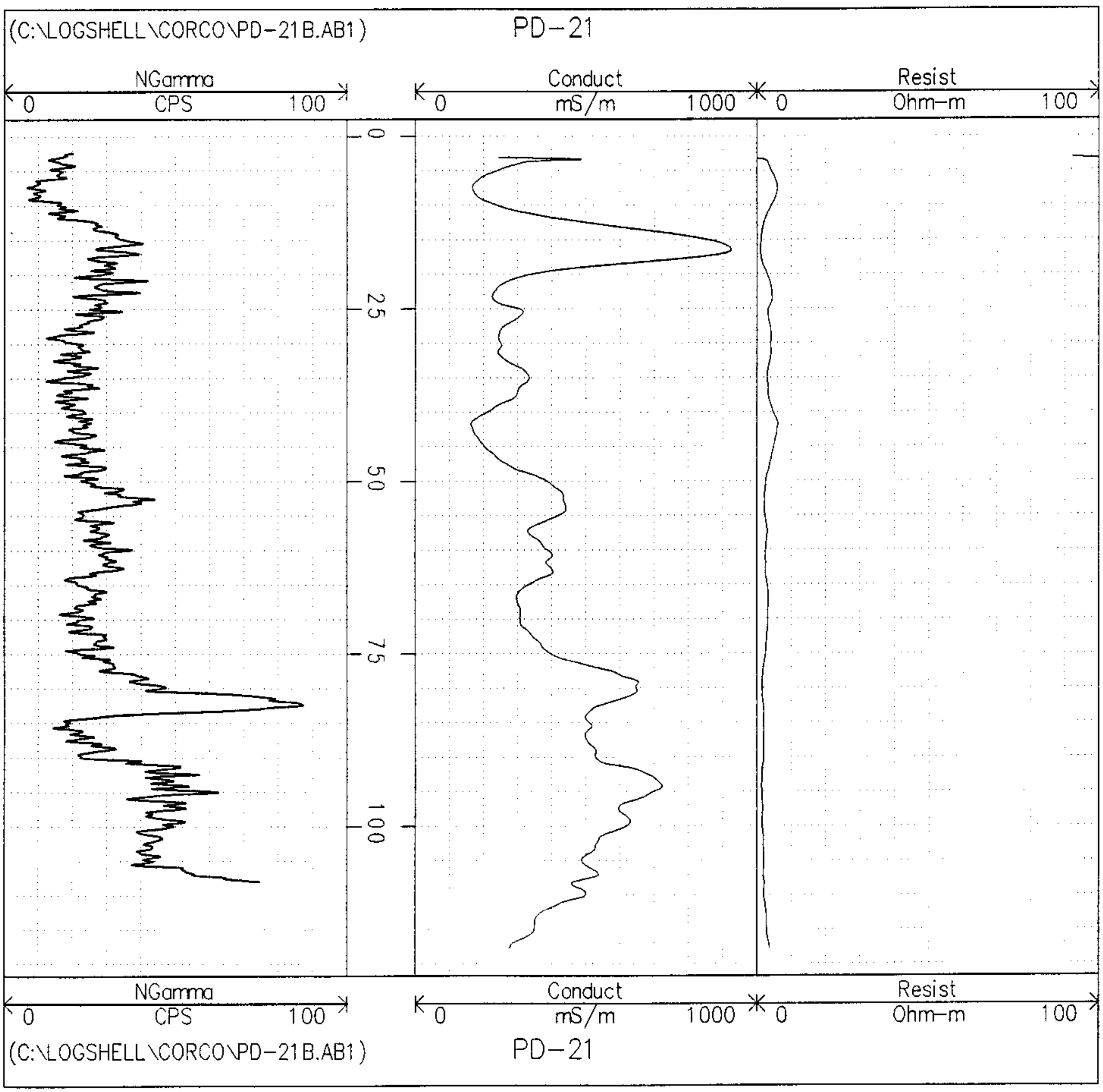
PD-20
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
0
25
50
75
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
(C:\LOGSHELL\CORCO\PD-20.AA1)
PD-20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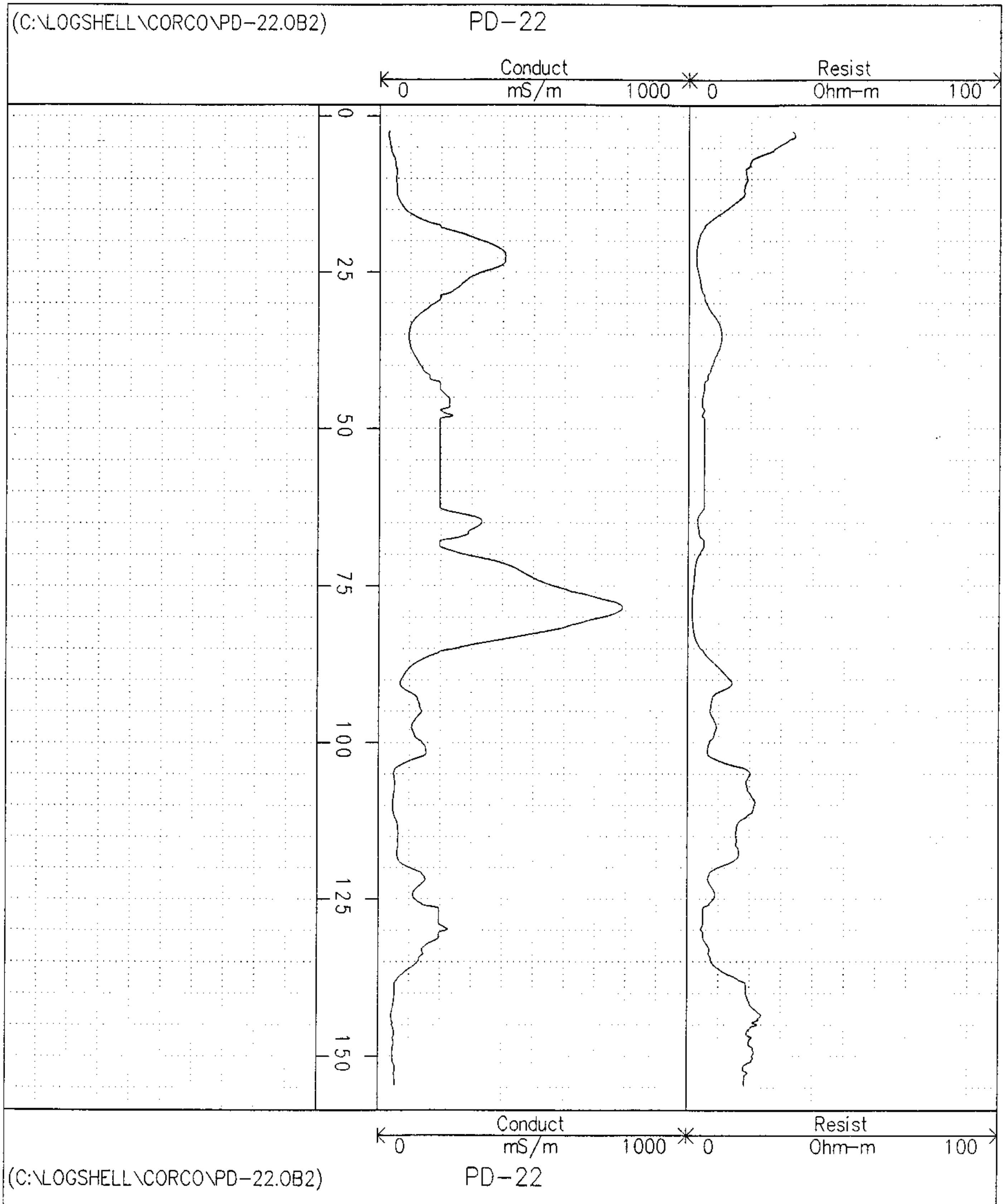
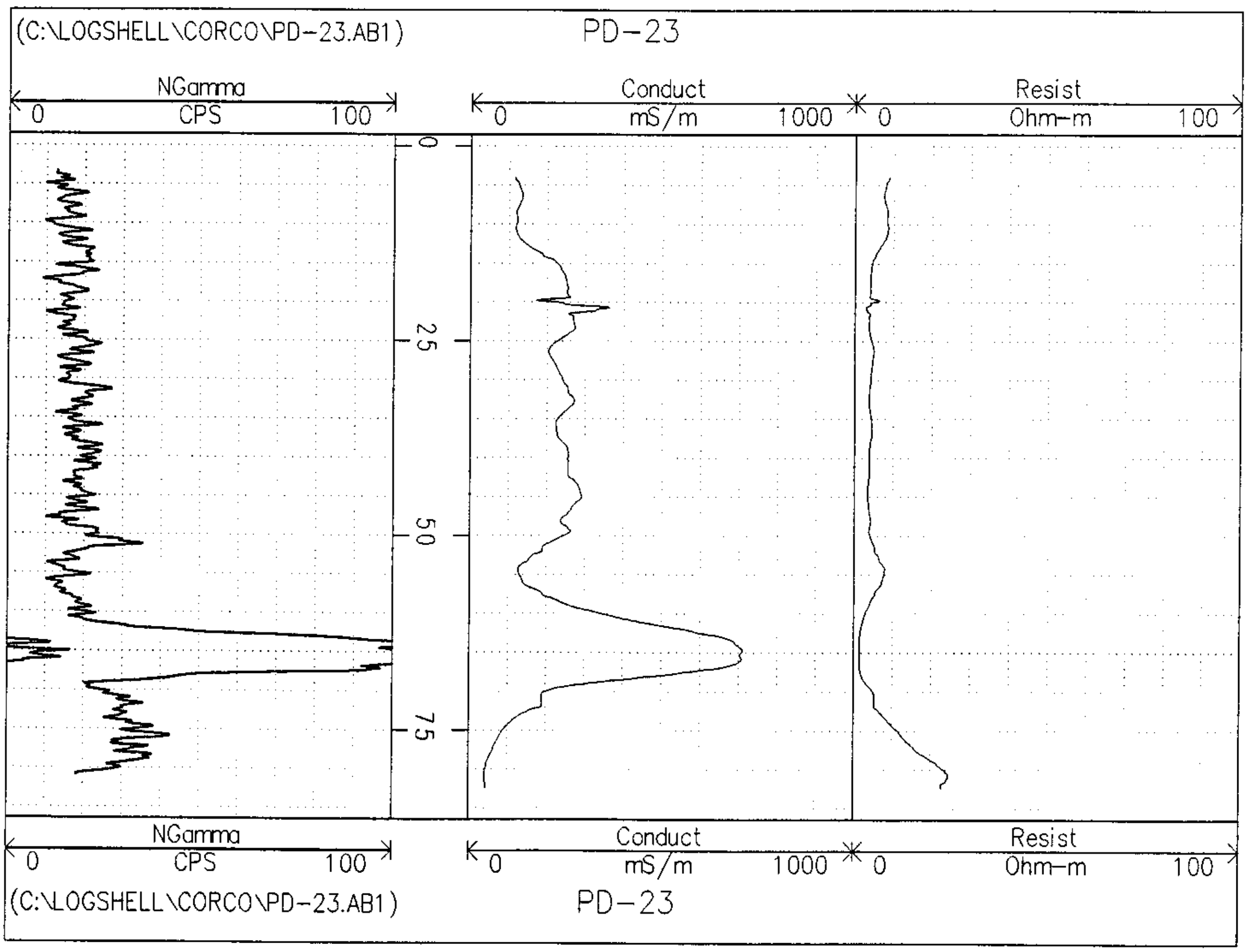
PD-21
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
0
25
50
75
100
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
(C:\LOGSHELL\CORCO\PD-21B.AB1)
PD-21



(C:\LOGSHELL\CORCO\PD-22.0B2)
PD-22
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
0
25
50
75
100
125
150
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-22.0B2)
PD-22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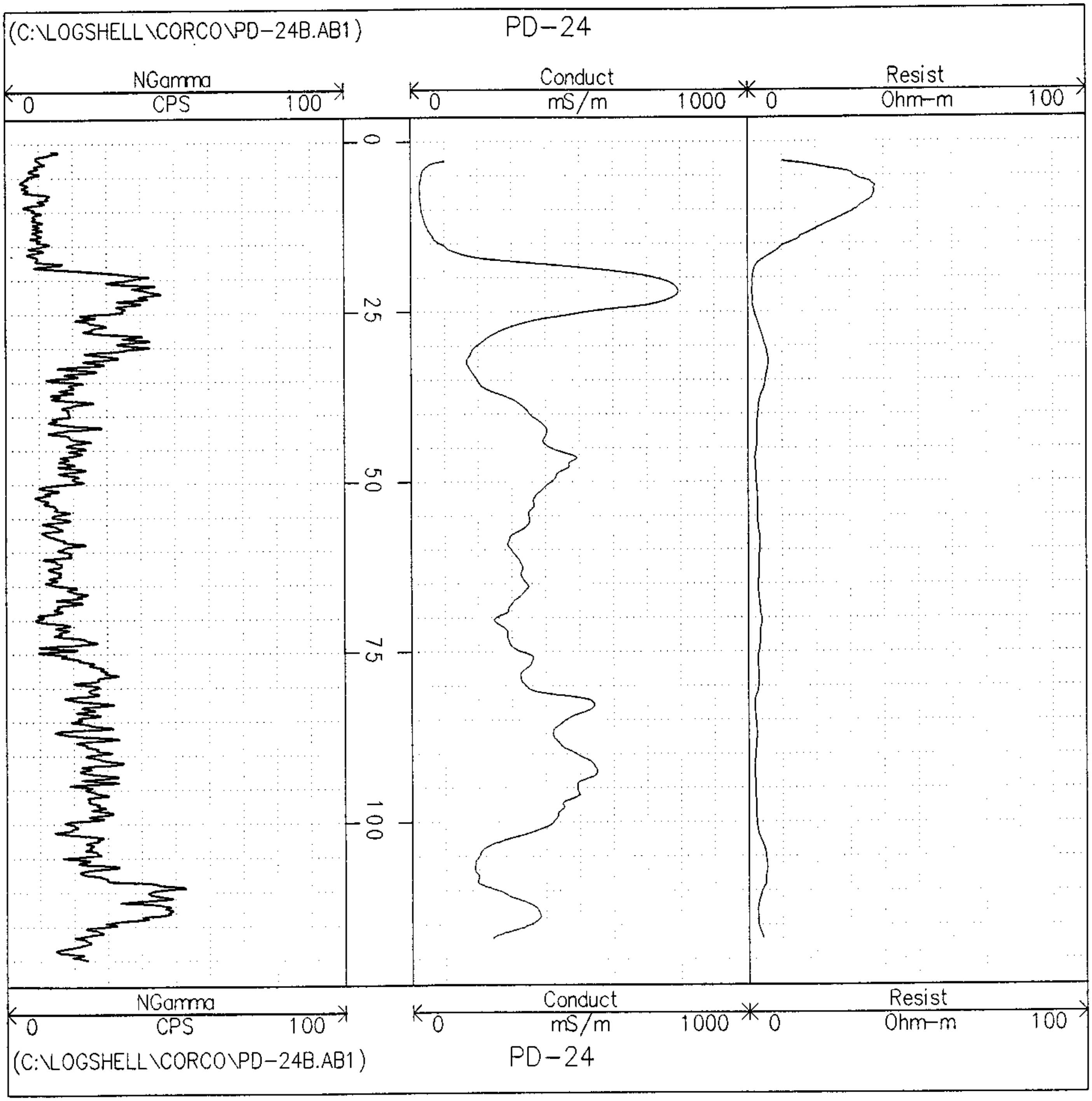
PD-23
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
0
25
50
75
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-23.AB1)
PD-23



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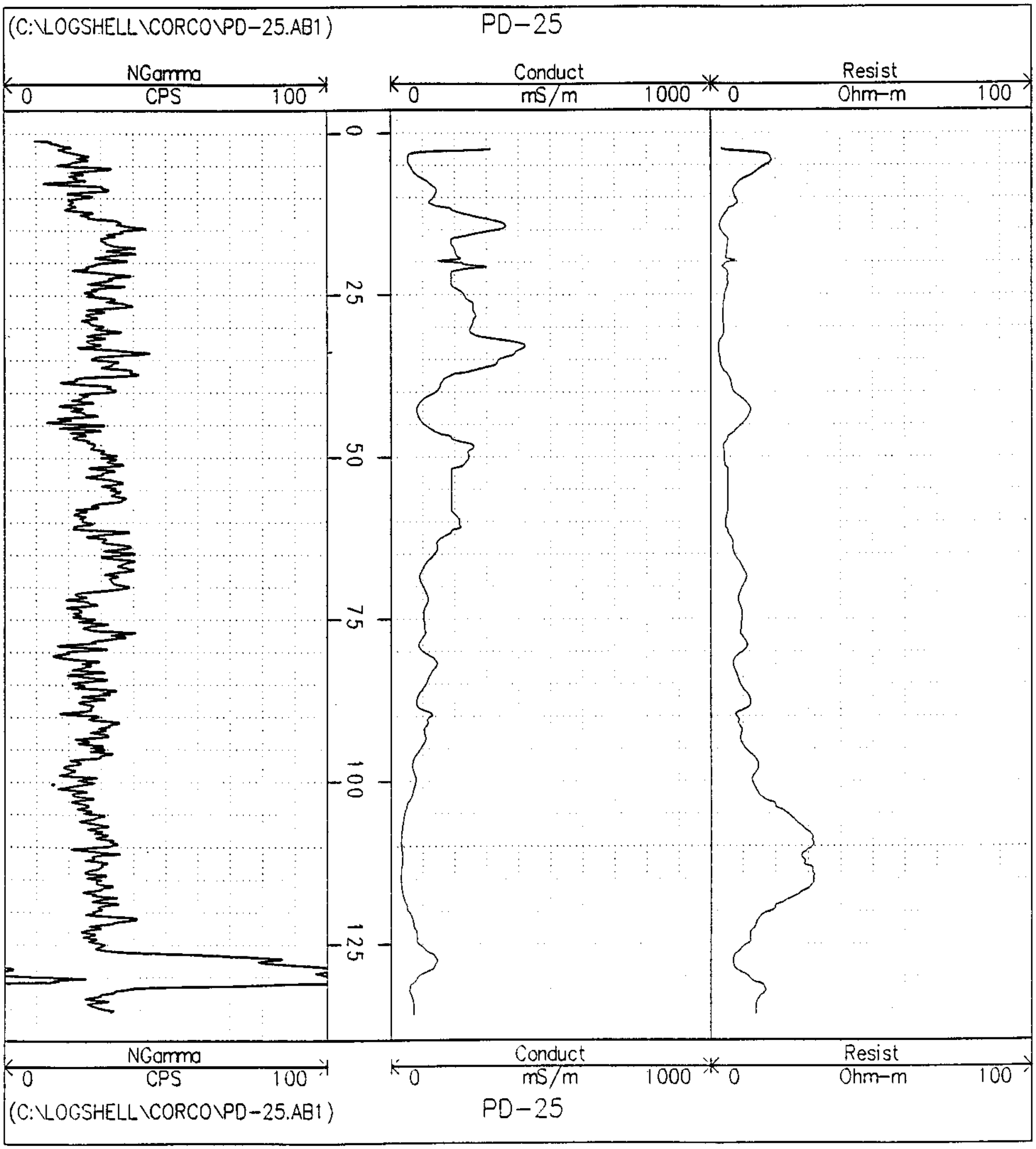
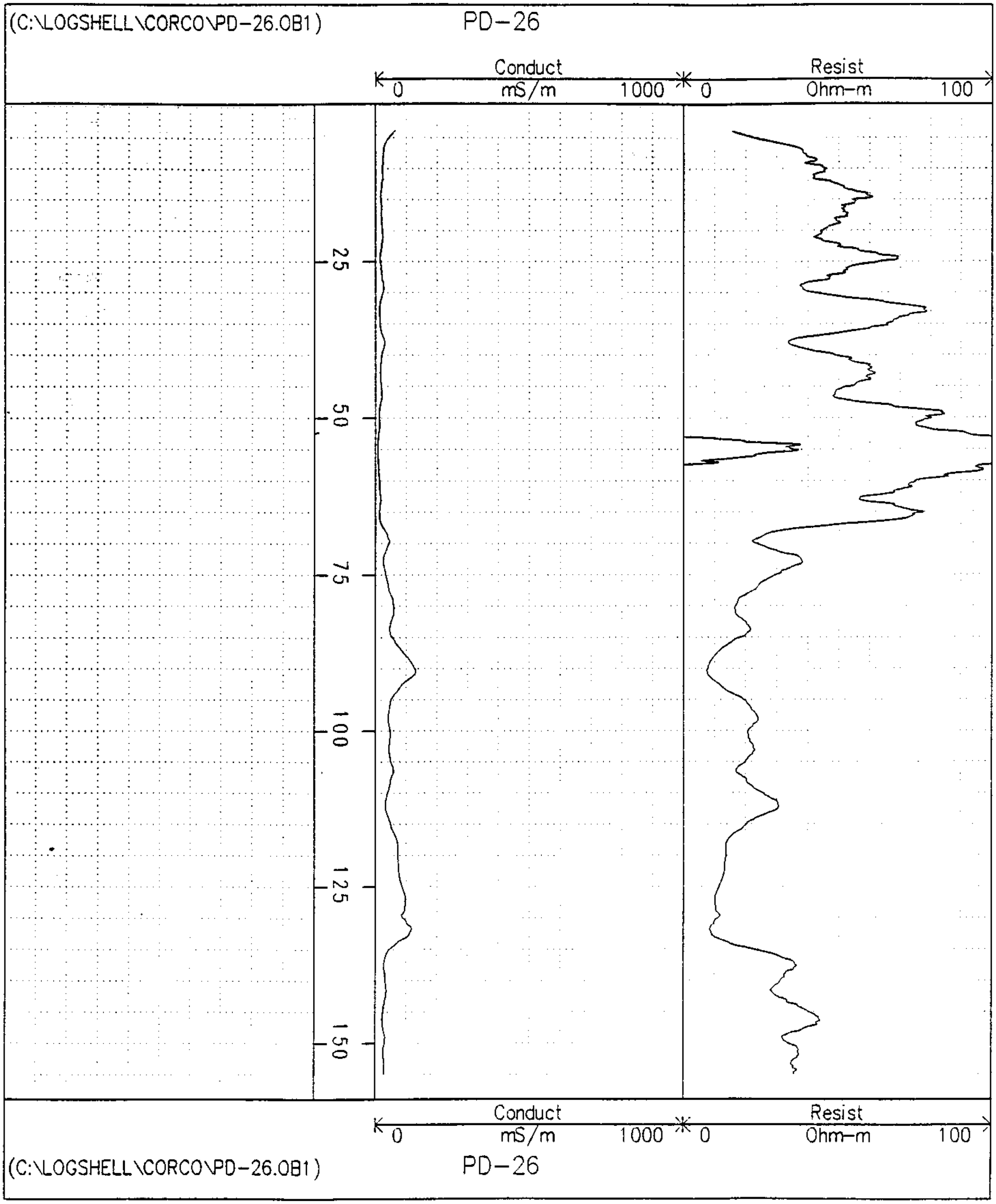
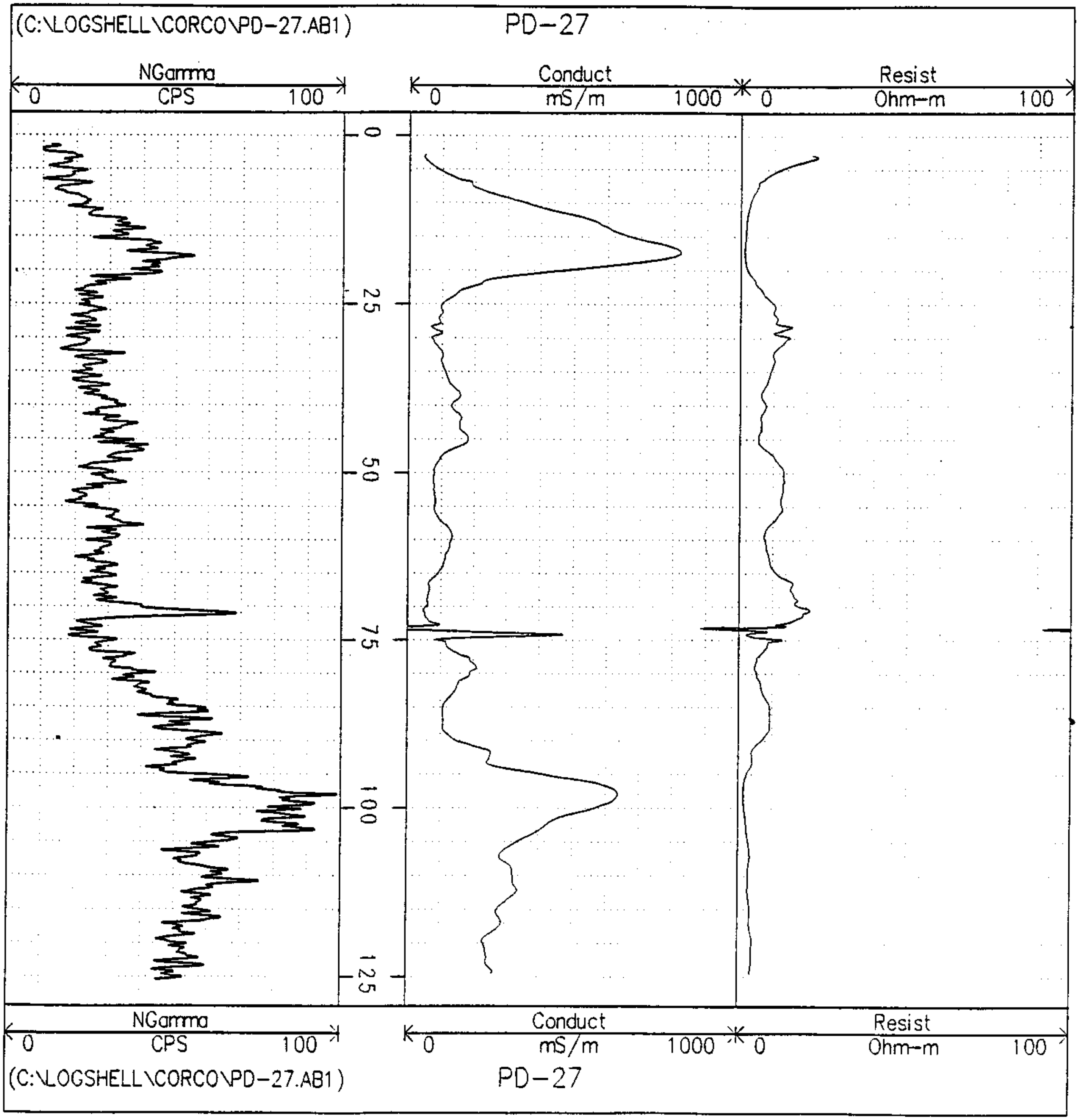
PD-24
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
0
25
50
75
100
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
(C:\LOGSHELL\CORCO\PD-24B.AB1)
PD-24



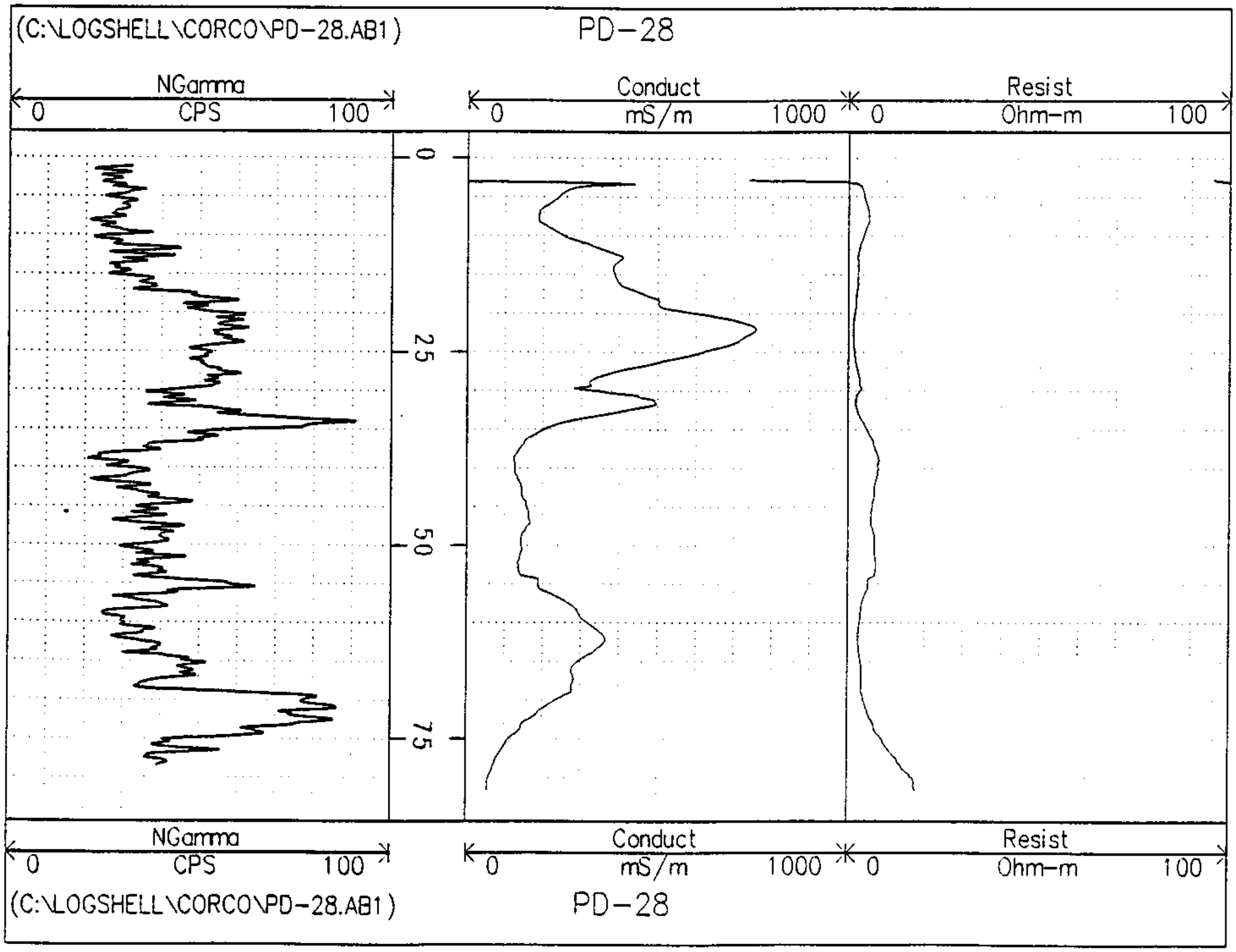
(C:\LOGSHELL\CORCO\PD-25.AB1)
PD-25
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
0
25
50
75
100
125
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
(C:\LOGSHELL\CORCO\PD-25.AB1)
PD-25



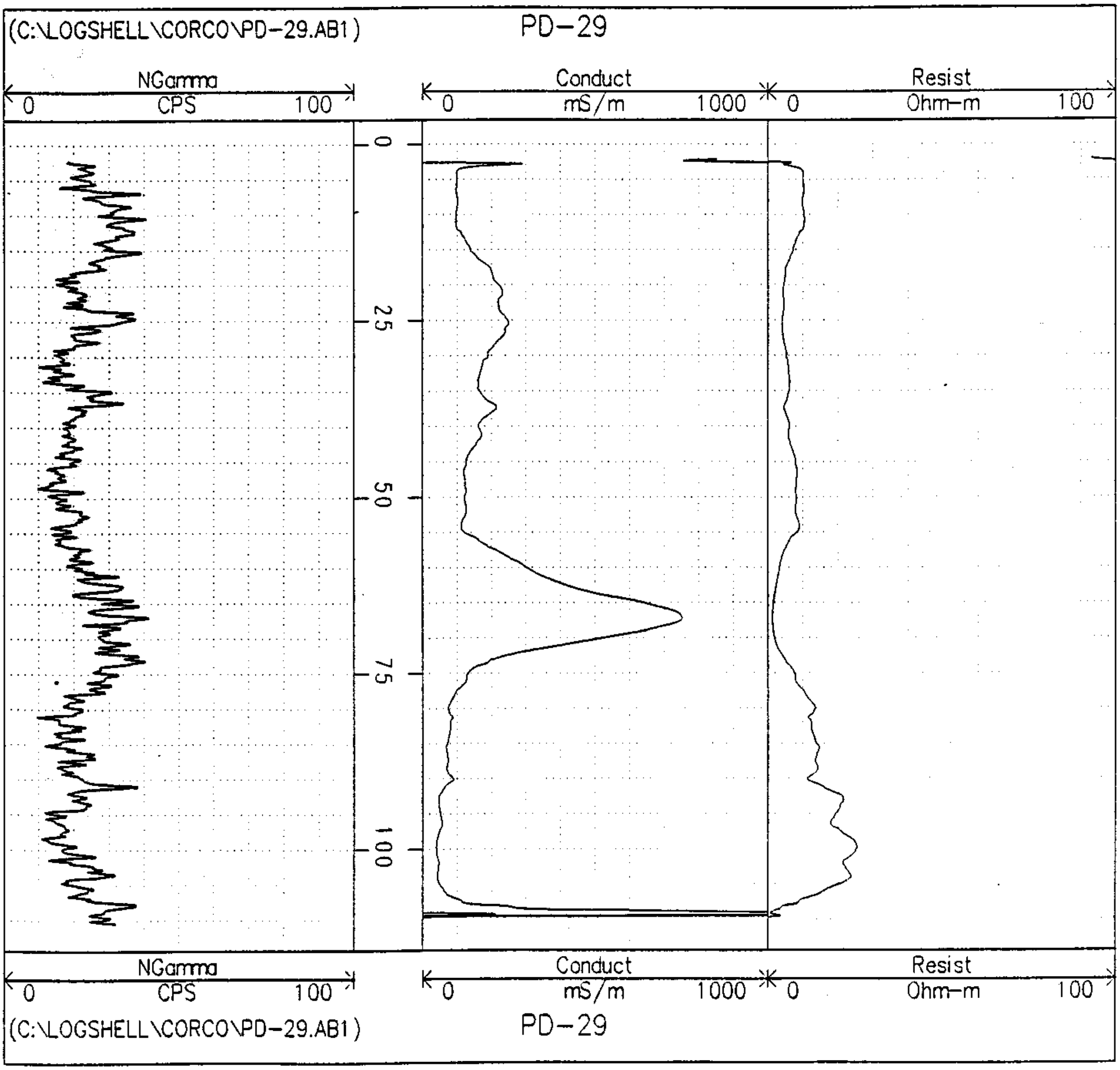
(C:\LOGSHELL\CORCO\PD-26.OB1)
PD-26
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
25
50
75
100
125
150
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-26.OB1)
PD-26

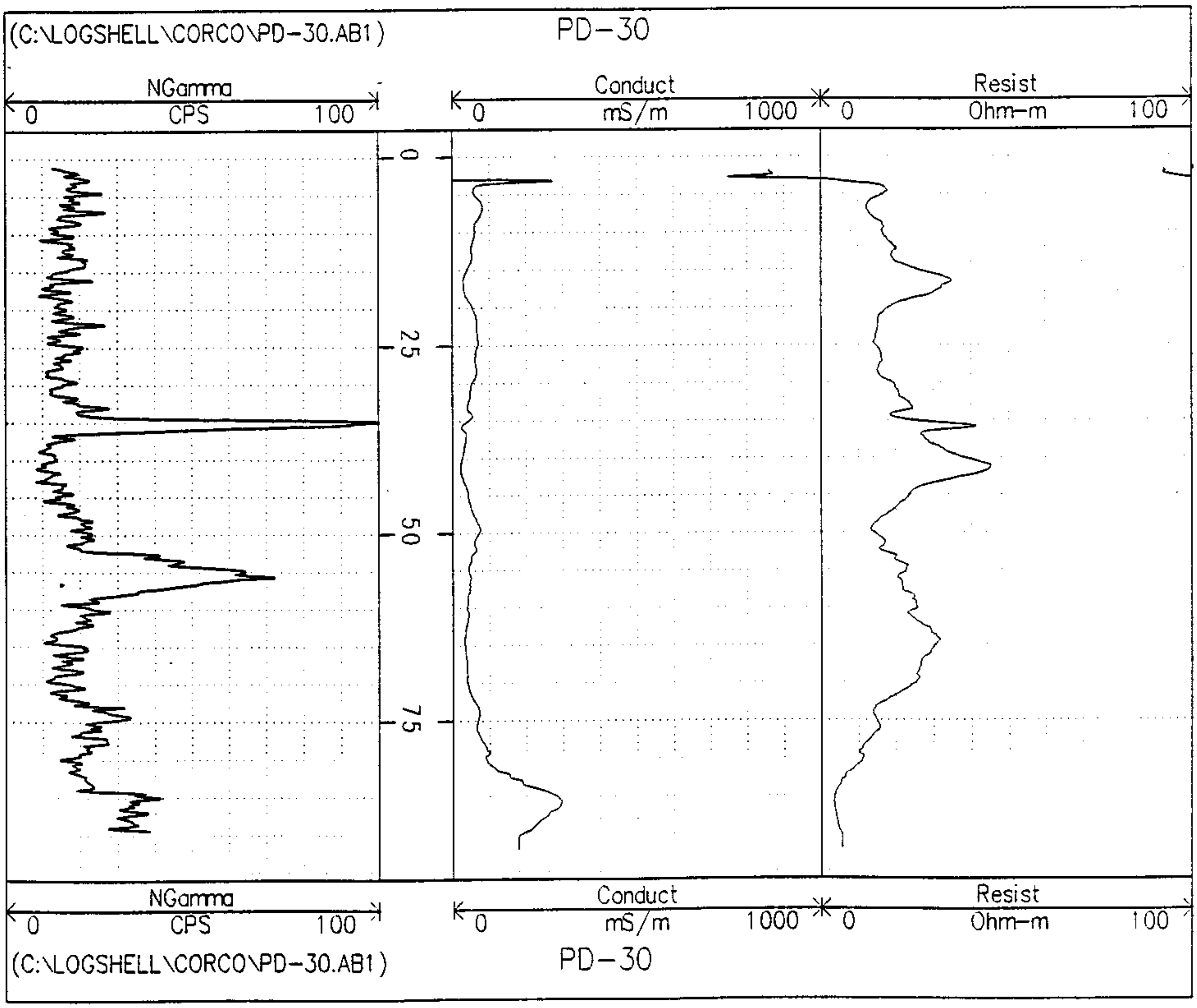


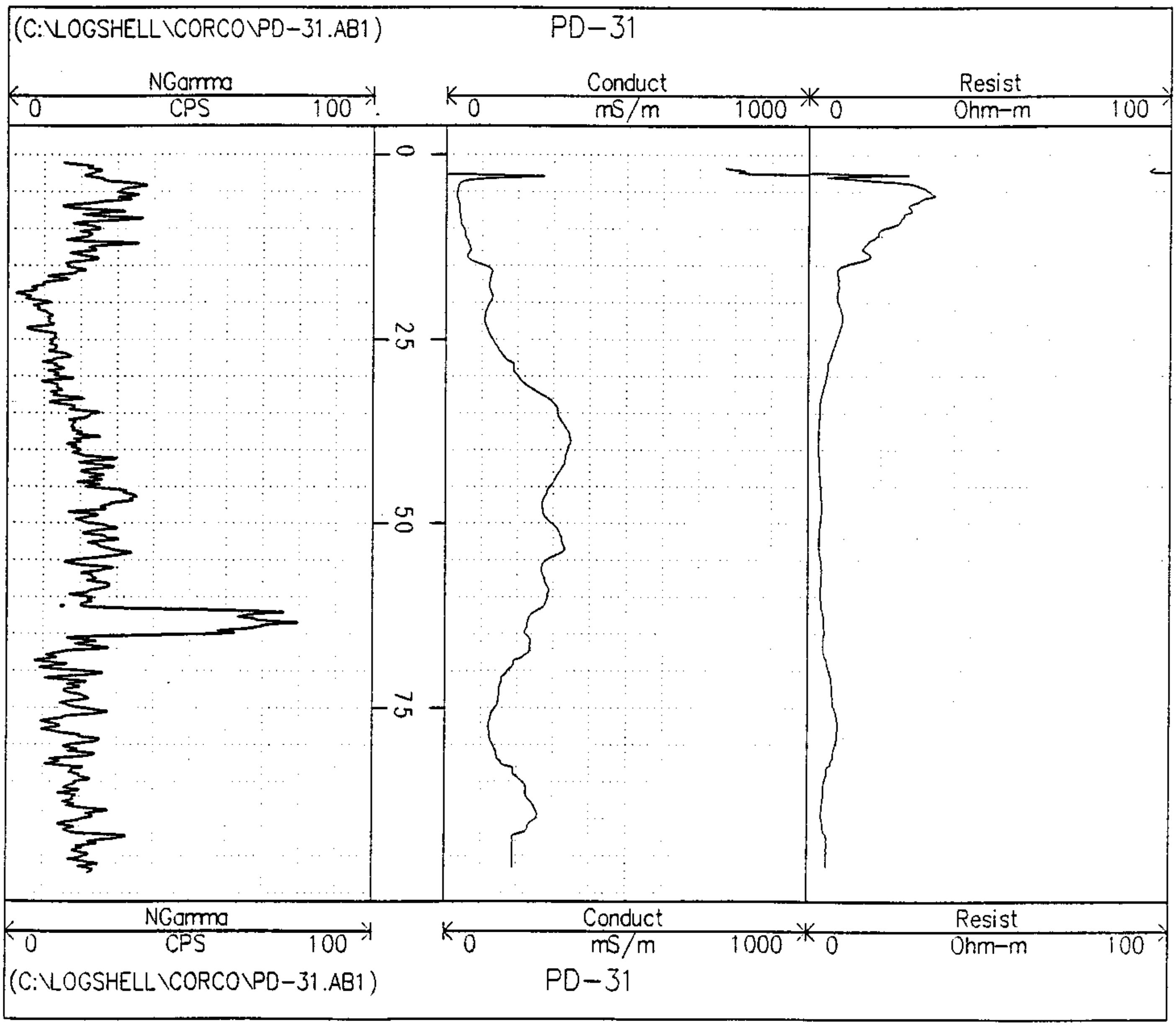
(C:\LOGSHELL\CORCO\PD-27.AB1)
PD-27
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
0
25
50
75
100
125
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-27.AB1)
PD-27

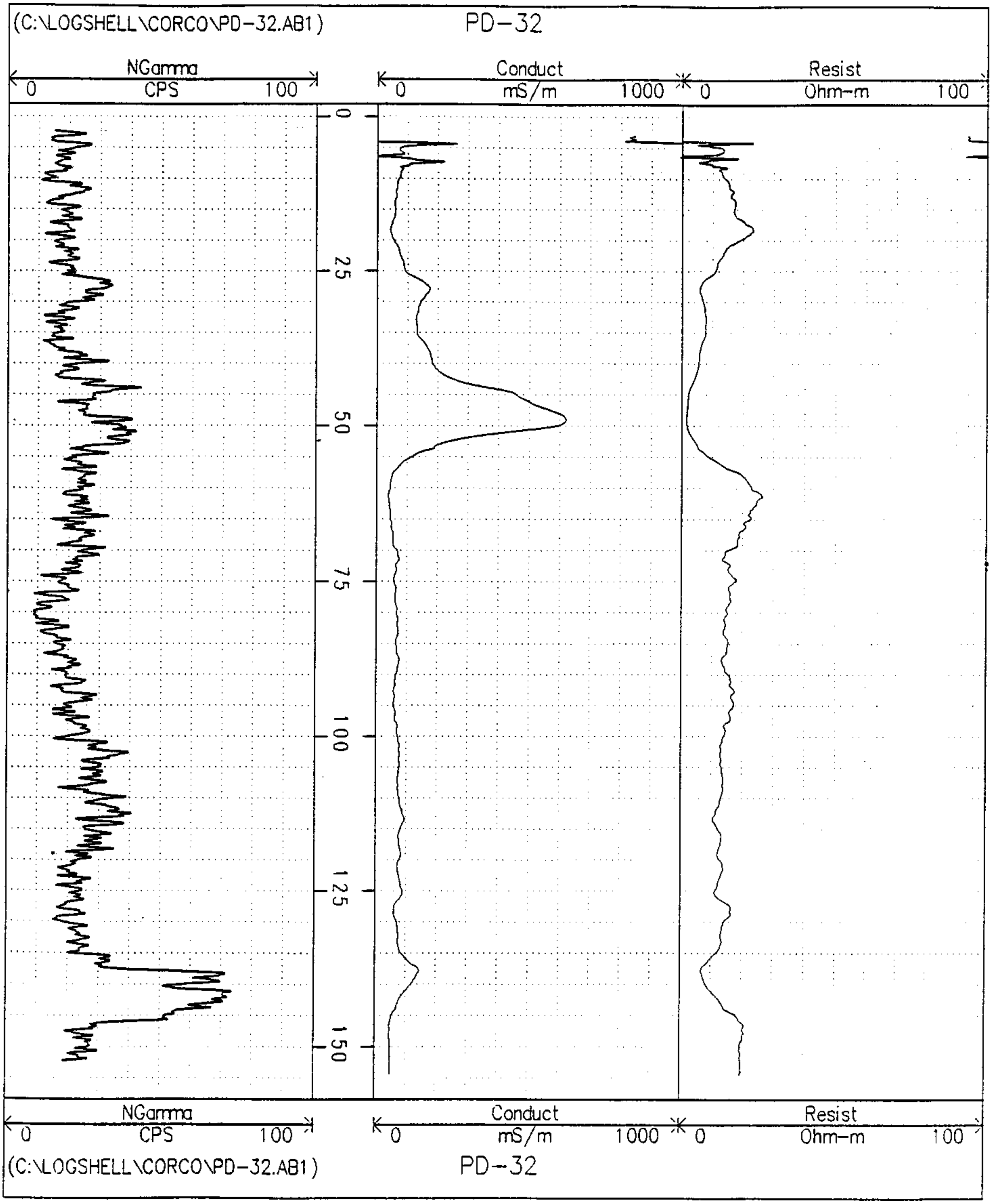


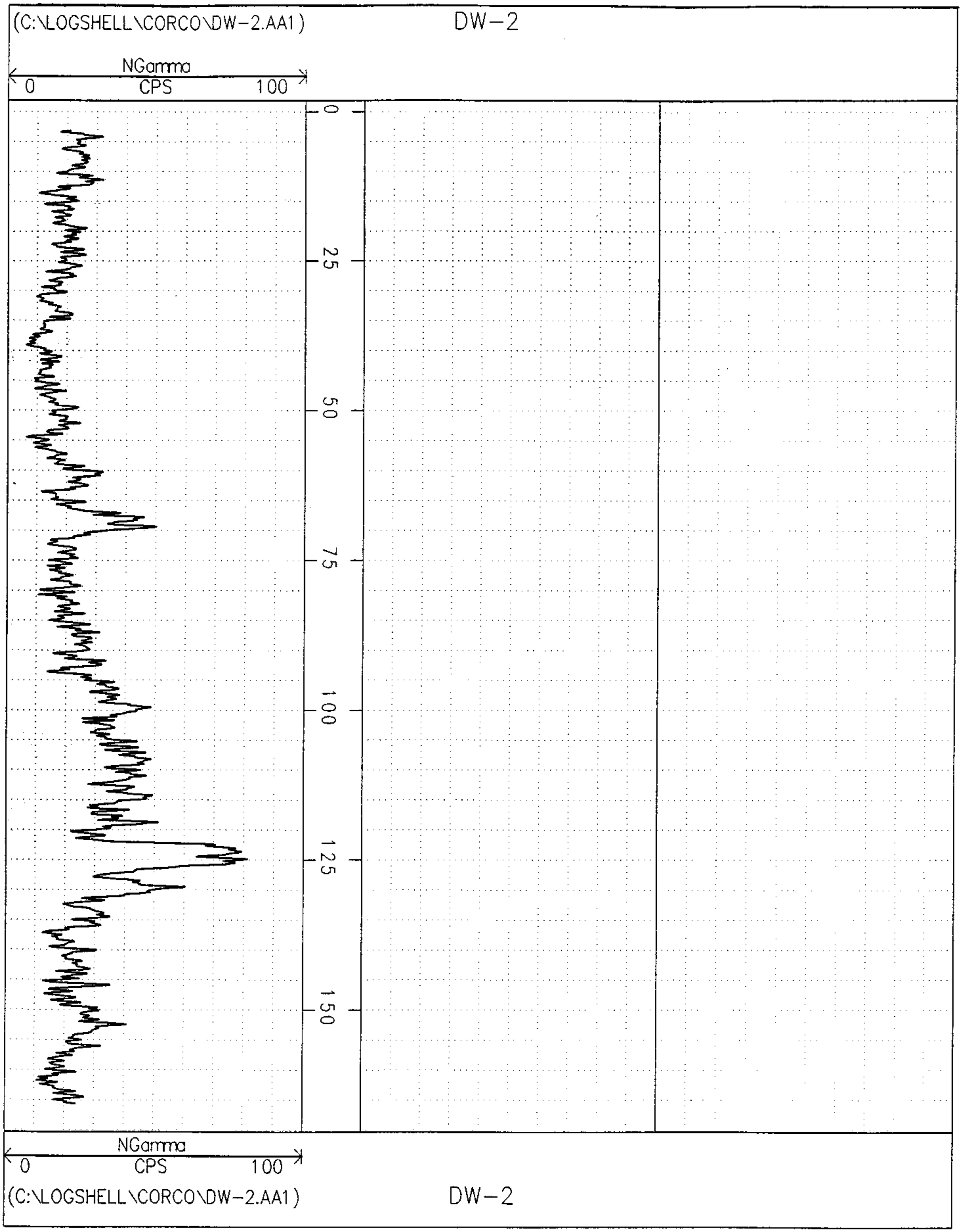
(C:\LOGSHELL\CORCO\PD-28.AB1)
PD-28
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
0
25
50
75
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-28.AB1)
PD-28


(C:\LOGSHELL\CORCO\PD-29.AB1)
PD-29
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
0
25
50
75
100
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
(C:\LOGSHELL\CORCO\PD-29.AB1)
PD-29

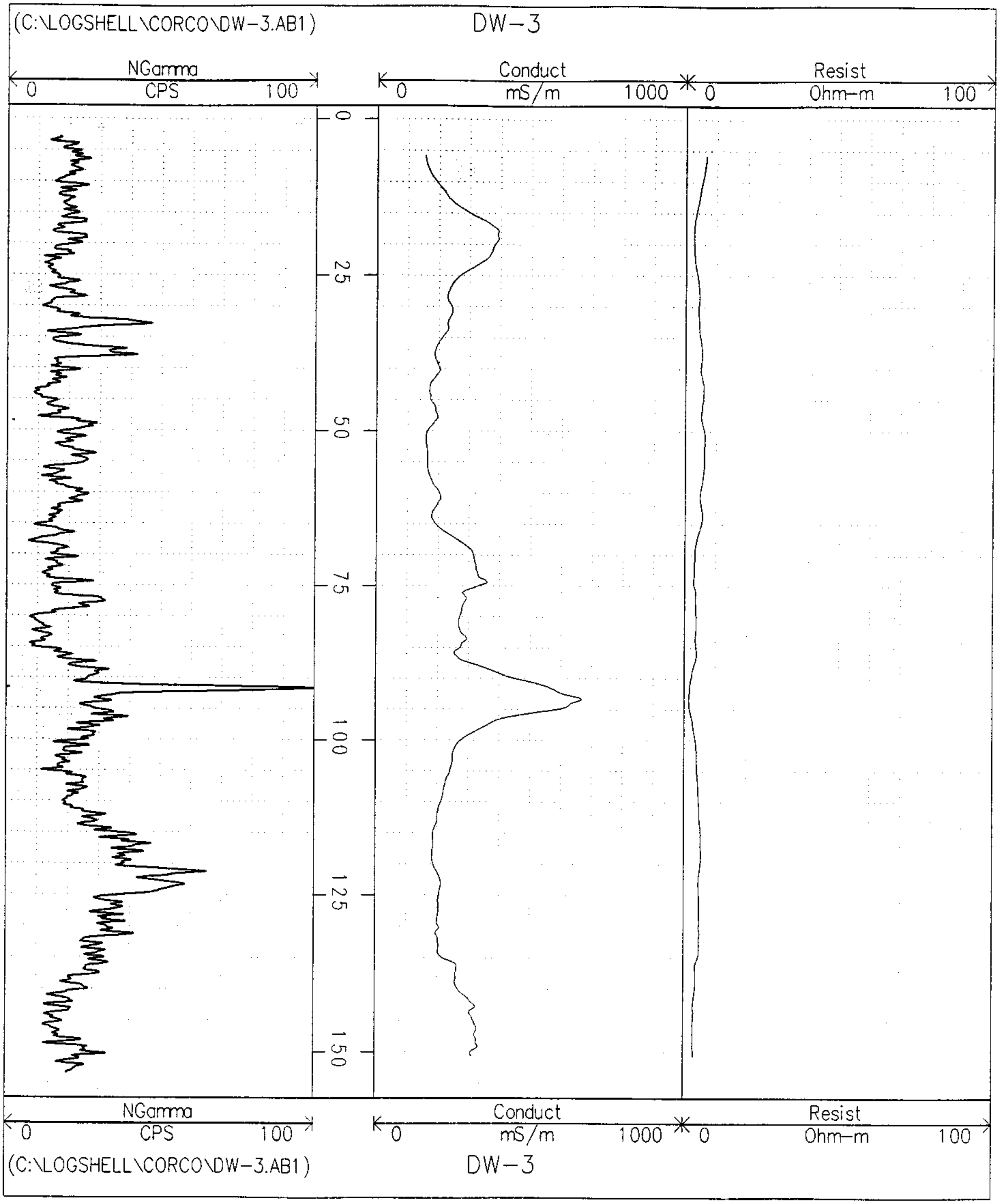

(C:\LOGSHELL\CORCO\PD-30.AB1)
PD-30
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
0
25
50
75
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
(C:\LOGSHELL\CORCO\PD-30.AB1)
PD-30


(C:\LOGSHELL\CORCO\PD-31.AB1)
PD-31
NGamma
CPS
0
100
Conduct
mS/m
0
1000
Resist
Ohm-m
0
100
0
25
50
75
NGamma
CPS
0
100
Conduct
mS/m
0
1000
Resist
Ohm-m
0
100
(C:\LOGSHELL\CORCO\PD-31.AB1)
PD-31

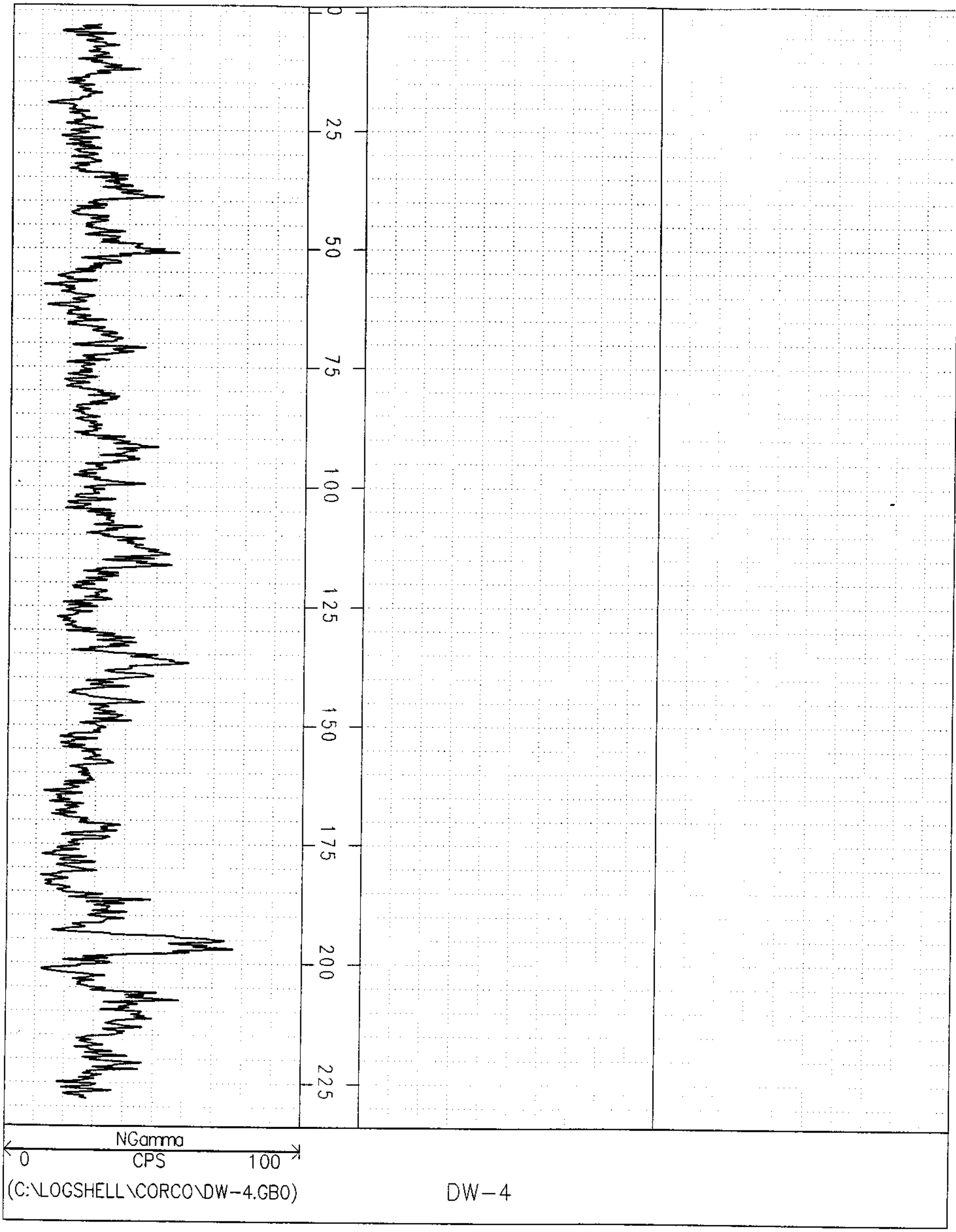

(C:\LOGSHELL\CORCO\PD-32.AB1)
PD-32
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
0
25
50
75
100
125
150
NGamma
0
CPS
100
Conduct
0
mS/m
1000
Resist
0
Ohm-m
100
(C:\LOGSHELL\CORCO\PD-32.AB1)
PD-32



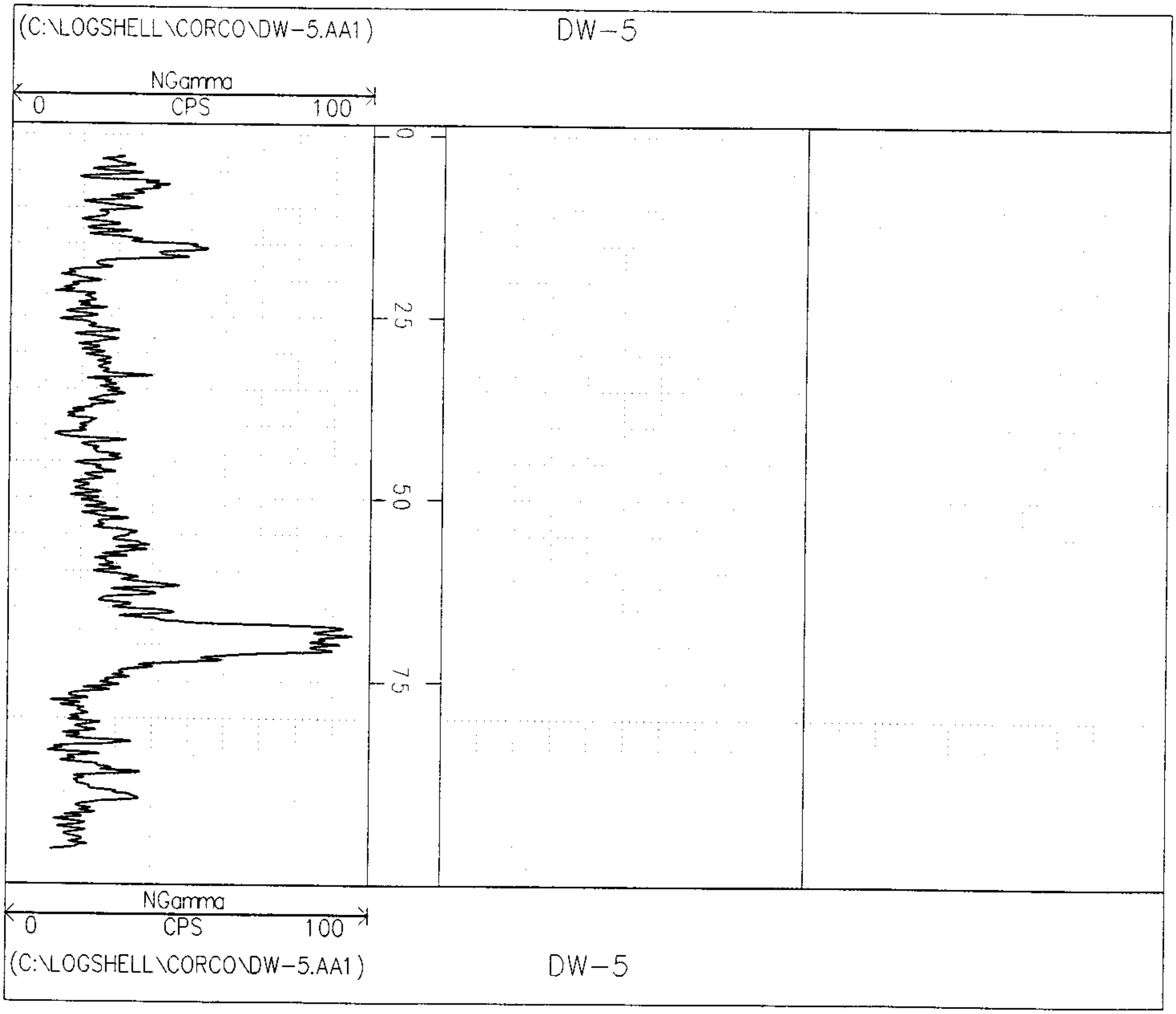
(C:\LOGSHELL\CORCO\DW-2.AA1)
DW-2
NGamma
0
CPS
100
0
25
50
75
100
125
150
NGamma
0
CPS
100
(C:\LOGSHELL\CORCO\DW-2.AA1)
DW-2

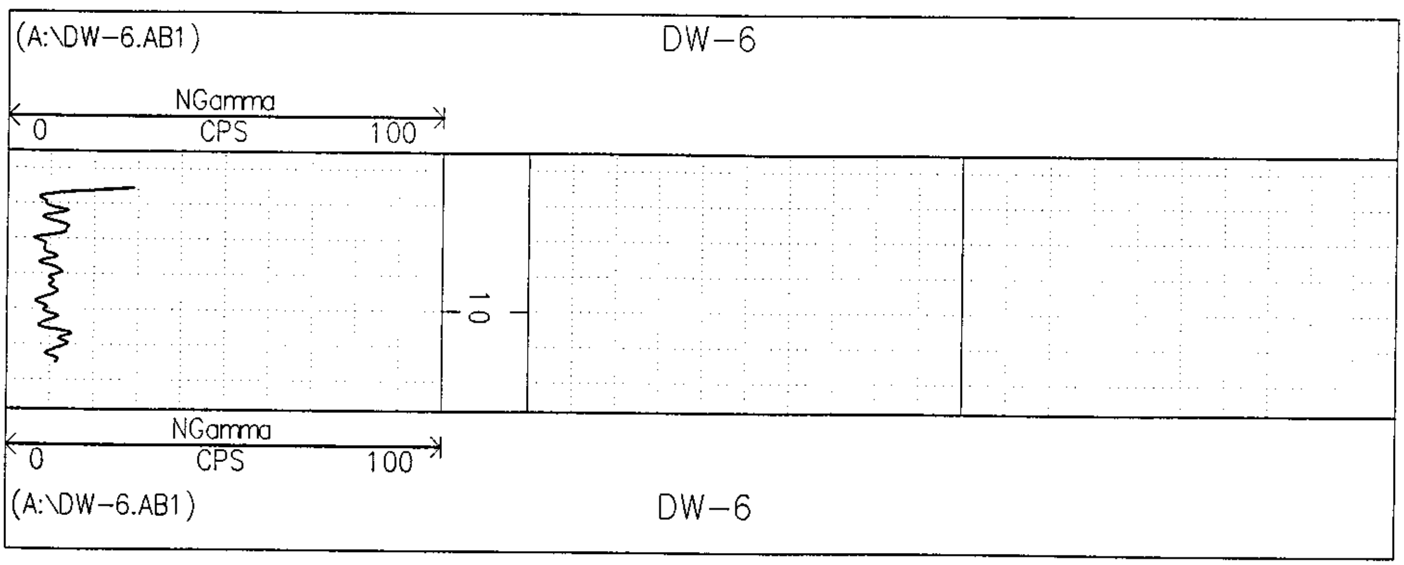


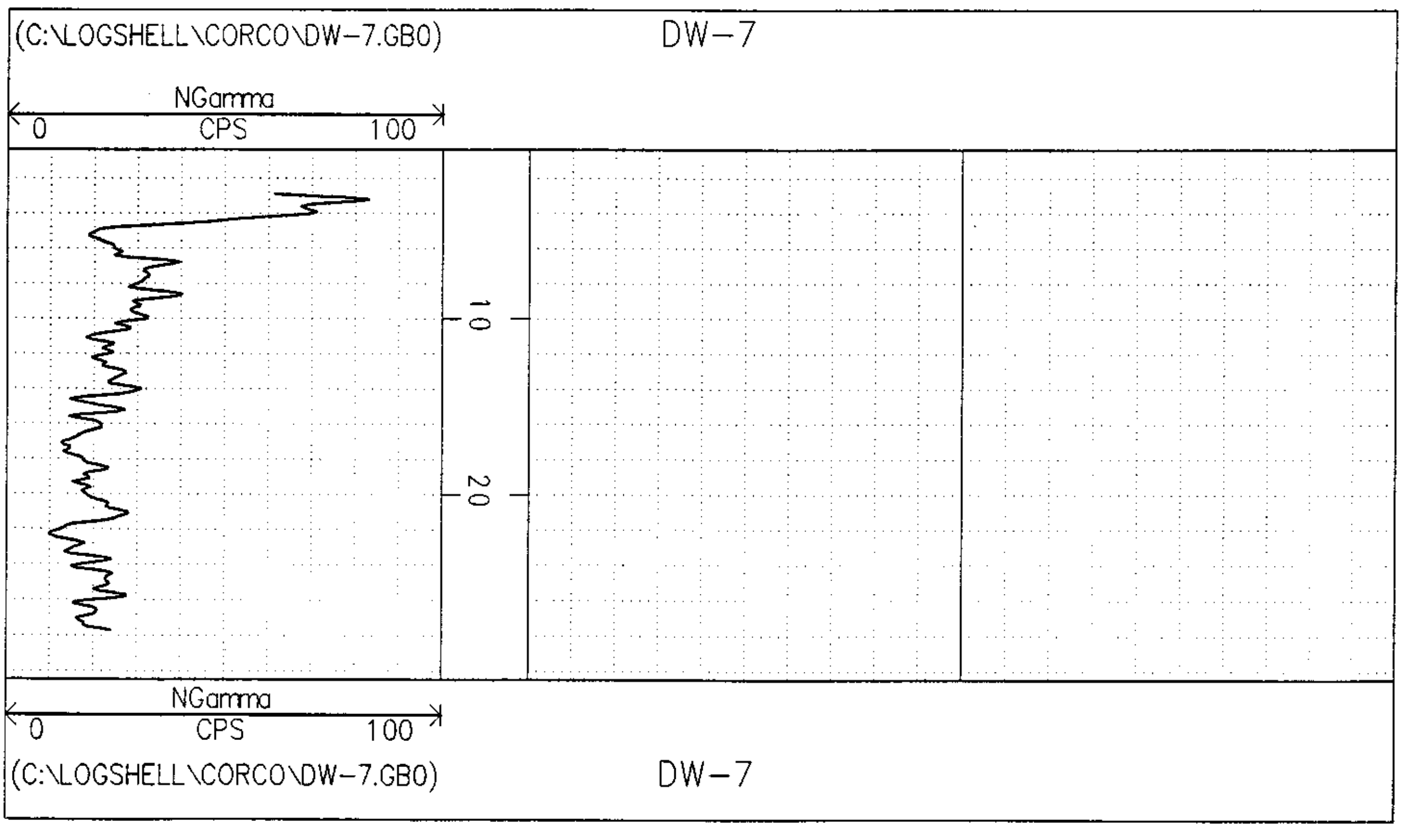
(C:\LOGSHELL\CORCO\DW-3.AB1)
DW-3
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
0
25
50
75
100
125
150
NGamma
0 CPS 100
Conduct
0 mS/m 1000
Resist
0 Ohm-m 100
(C:\LOGSHELL\CORCO\DW-3.AB1)
DW-3

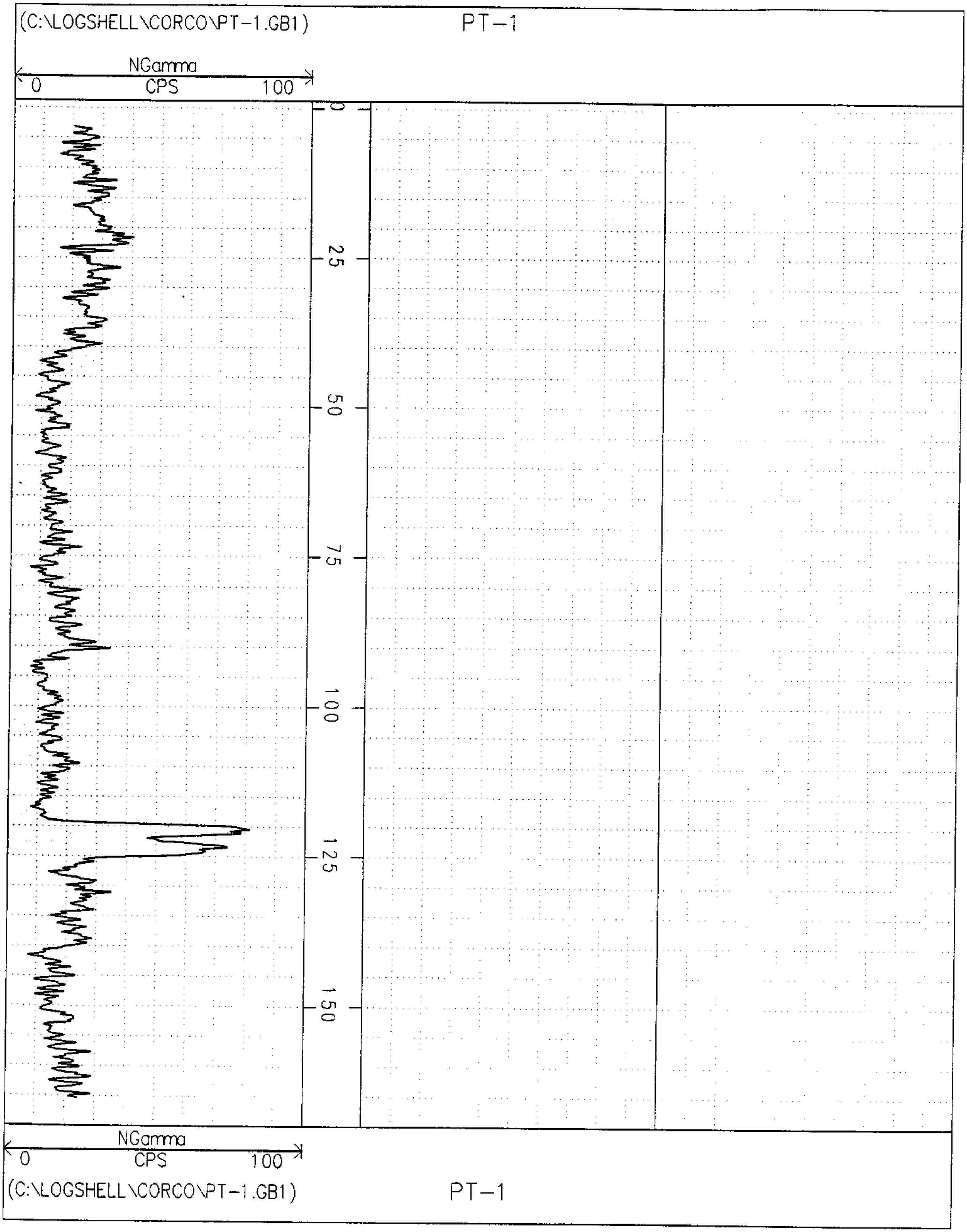


0
25
50
75
100
125
150
175
200
225
NGamma
0
CPS
100
(C:\LOGSHELL\CORCO\DW-4.GB0)
DW-4

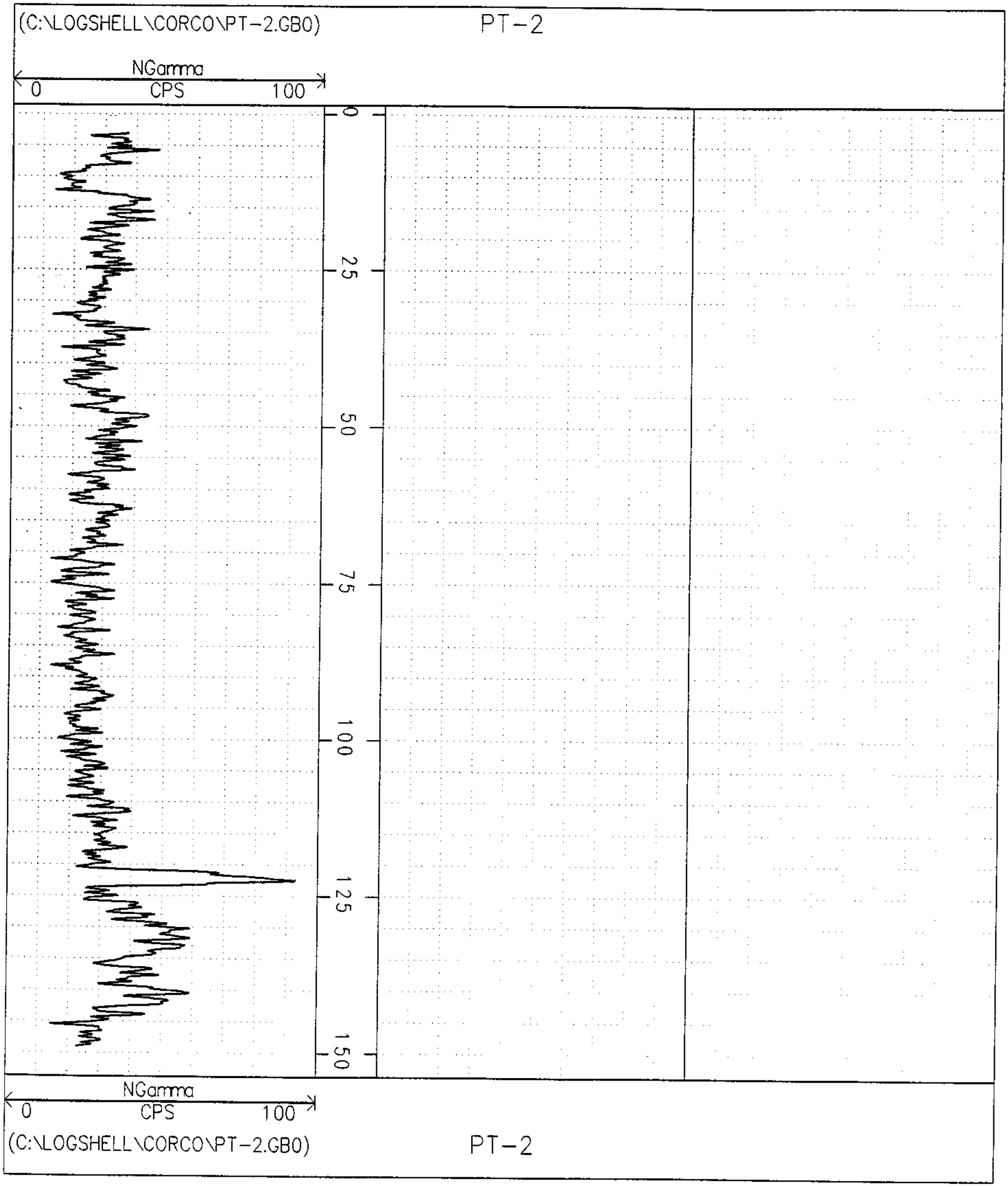

(C:\LOGSHELL\CORCO\DW-5.AA1)
DW-5
NGamma
0
CPS
100
0
25
50
75
NGamma
0
CPS
100
(C:\LOGSHELL\CORCO\DW-5.AA1)
DW-5


(A:\DW-6.AB1)
DW-6
NGamma
0
CPS
100
10
NGamma
0
CPS
100
(A:\DW-6.AB1)
DW-6

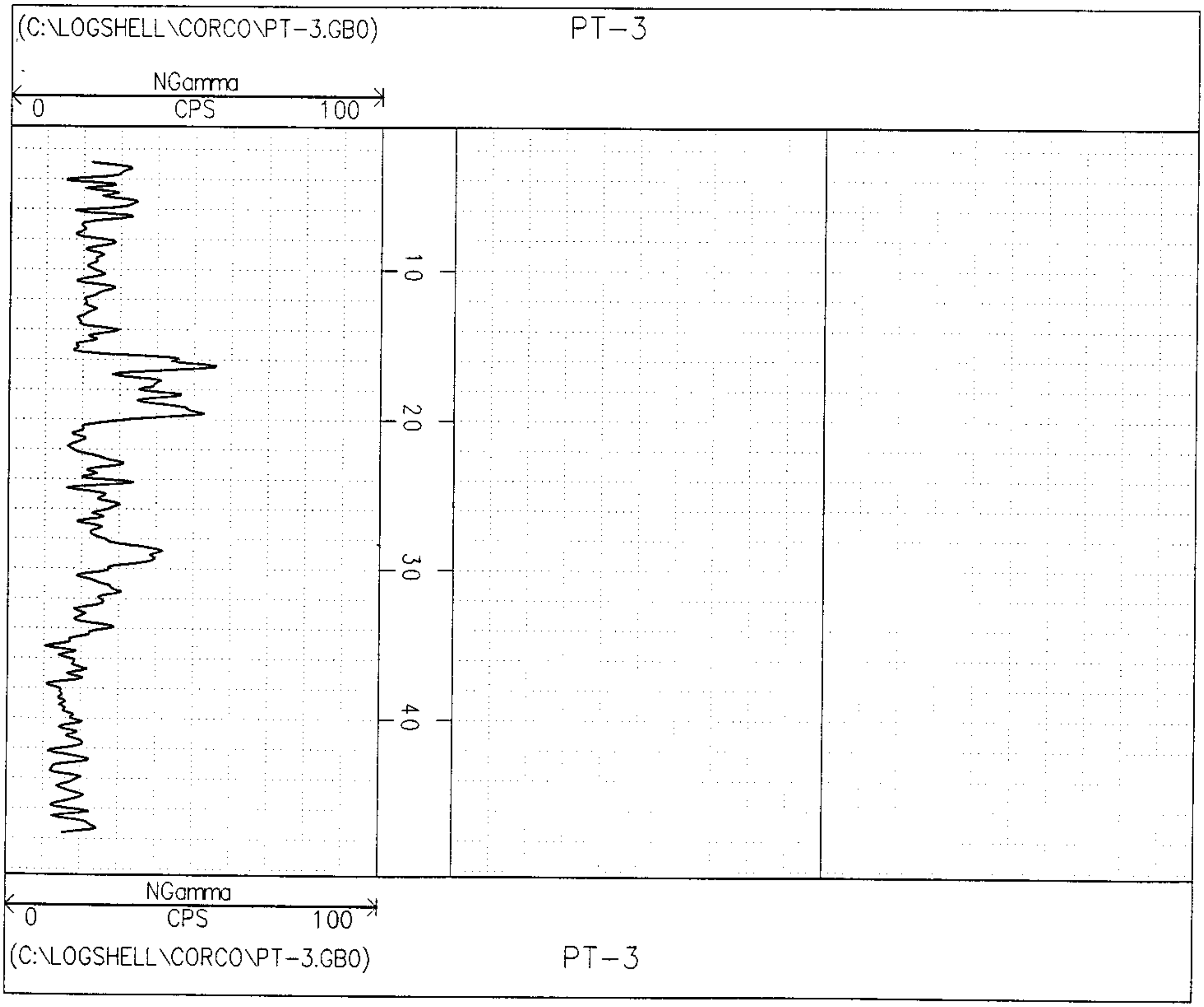

(C:\LOGSHELL\CORCO\DW-7.GB0)
DW-7
NGamma
0
CPS
100
10
20
NGamma
0
CPS
100
(C:\LOGSHELL\CORCO\DW-7.GB0)
DW-7



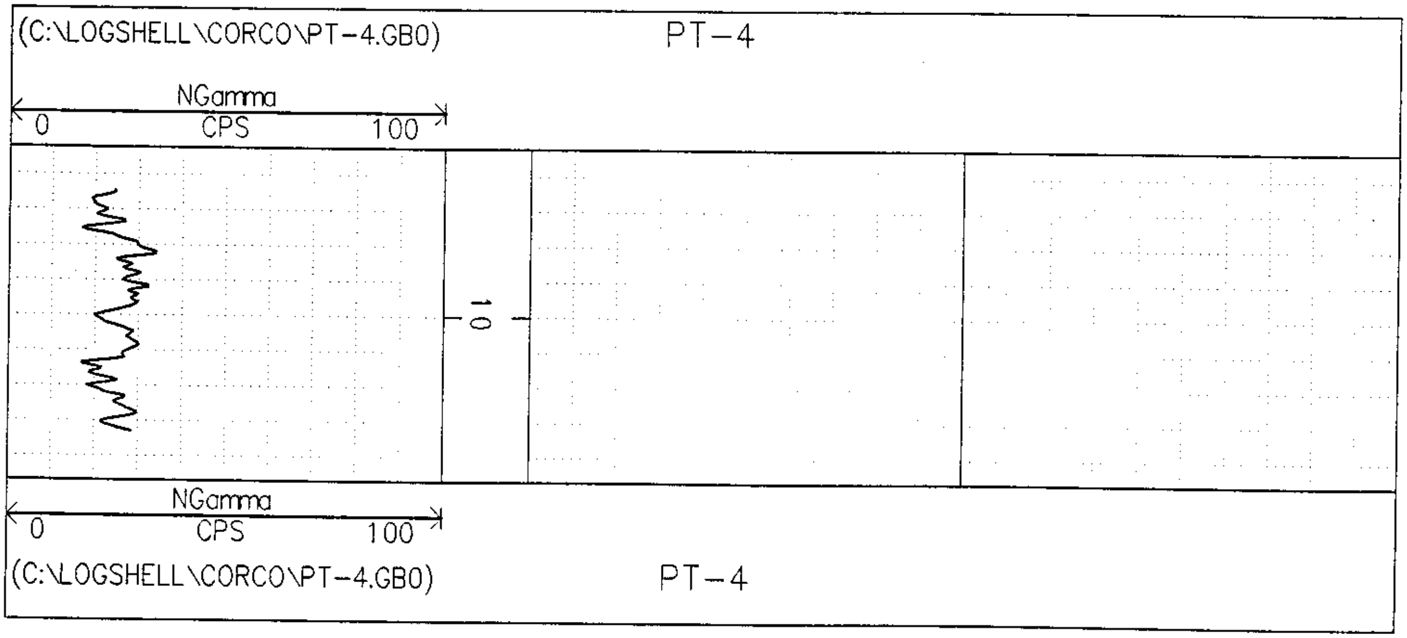
(C:\LOGSHELL\CORCO\PT-1.GB1)
PT-1
NGamma
0
CPS
100
0
25
50
75
100
125
150
NGamma
0
CPS
100
(C:\LOGSHELL\CORCO\PT-1.GB1)
PT-1



(C:\LOGSHELL\CORCO\PT-2.GB0)
PT-2
NGamma
0
CPS
100
0
25
50
75
100
125
150
NGamma
0
CPS
100
(C:\LOGSHELL\CORCO\PT-2.GB0)
PT-2



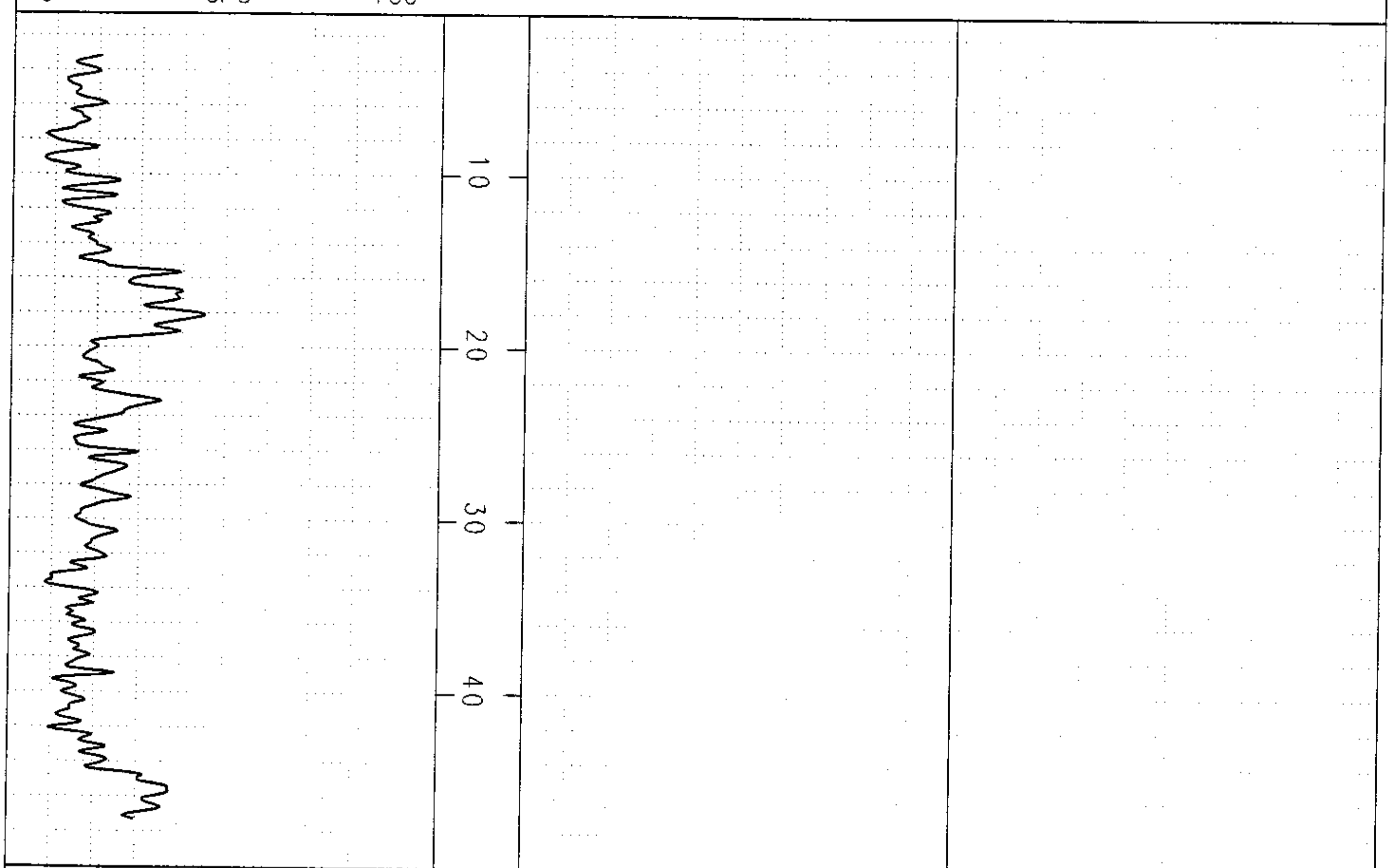
(C:\LOGSHELL\CORCO\PT-3.GB0)
PT-3
NGamma
0
CPS
100
10
20
30
40
NGamma
0
CPS
100
(C:\LOGSHELL\CORCO\PT-3.GB0)
PT-3


(C:\LOGSHELL\CORCO\PT-4.GB0)
PT-4
NGamma
0
CPS
100
10
NGamma
0
CPS
100
(C:\LOGSHELL\CORCO\PT-4.GB0)
PT-4

(C:\LOGSHELL\CORCO\PT-5.GB1) PT-5

NGamma

0 CPS 100



NGamma

0 CPS 100

(C:\LOGSHELL\CORCO\PT-5.GB1) PT-5

APPENDIX F-2
GROUNDWATER SAMPLE ANALYTICAL DATA

ENVIROLABS INC.
INDUSTRIAL AND ENVIRONMENTAL LABORATORIES

August 31, 1995

DSM Environmental
Services, Inc.
1830 S. Kirkwood
Suite 201A
Houston, Texas 77077

ANALYSIS REPORT

Sample Identification:

Sample from DSM Environmental Service, Inc.
Identified as Water Sample/PD-4
August 8, 1995
Envirolabs No. 75-827

Conductivity (umhos/cm)	*56,550*
Chlorides (mg/L)	*19,961*
Calcium (mg/L)	*263*
Magnesium (mg/L)	*203*
Potassium (mg/L)	*229*
Sodium (mg/L)	*7,150*

Químico Licenciado
IRIS M. CHEVERE ALFONZO
LIC. 2370
Estado Libre Asociado de P.R.

ANALYSIS REPORT

Sample Identification:

Sample from DSM Environmental Service, Inc.
Identified as Water Sample/PD-5
August 8, 1995
Envirolabs No. 75-828

Conductivity (umhos/cm)	*18,980*
Chlorides (mg/L)	*6,432*
Calcium (mg/L)	*196*
Magnesium (mg/L)	*165*
Potassium (mg/L)	*25*
Sodium (mg/L)	*3,649*

ANALYSIS REPORT

Sample Identification:

Sample from DSM Environmental Service, Inc.
Identified as Water Sample/PD-12
August 8, 1995
Envirolabs No. 75-829

Conductivity (umhos/cm)	*5,460*
Chlorides (mg/L)	*1,927*
Calcium (mg/L)	*577*
Magnesium (mg/L)	*134*
Potassium (mg/L)	*73*
Sodium (mg/L)	*1,500*

Químico Licenciado
IRIS M.
CHEVERE
ALFONZO
LIC. 2370
Estado Libre Asociado de P.R.

ANALYSIS REPORT

Sample Identification:

Sample from DSM Environmental Service, Inc.
Identified as Water Sample/PD-14
August 8, 1995
Envirolabs No. 75-830

Conductivity (umhos/cm)	*3,770*
Chlorides (mg/L)	*906*
Calcium (mg/L)	*92*
Magnesium (mg/L)	*41*
Potassium (mg/L)	*21*
Sodium (mg/L)	*825*

Químico Licenciado
IRIS M. CHEVERE ALFONZO
LIC. 2370
Asociado de P.R.

ANALYSIS REPORT

Sample Identification:

Sample from DSM Environmental Service, Inc.
Identified as Water Sample/PD-21
August 9, 1995
Envirolabs No. 75-831

Conductivity (umhos/cm)	*11,830*
Chlorides (mg/L)	*4,992*
Calcium (mg/L)	*308*
Magnesium (mg/L)	*175*
Potassium (mg/L)	*40*
Sodium (mg/L)	*2,600*

Químico Licenciado
IRIS M.
ALFONZO
LIC. 2370
Estado Libre Asociado de P.R.

ENVIROLABS INC. - SABANETAS INDUSTRIAL PARK - PONCE. P. R.

ANALYSIS REPORT

Sample Identification:

Sample from DSM Environmental Service, Inc.
Identified as Water Sample/MW-1
August 9, 1995
Envirolabs No. 75-832

Conductivity (umhos/cm)	*1,907*
Chlorides (mg/L)	*488*
Calcium (mg/L)	*15*
Magnesium (mg/L)	*52*
Potassium (mg/L)	*7.4*
Sodium (mg/L)	*337*

Quimico Licenc...
IRIS M.
CHEVERE
ALFONZO
LIC. 2170
Estado Libre Asociado de ...

$1.00 $1.00
A 378355

DSM ENVIRONMENTAL SERVICES INC.

1830 S. Kirkwood, Suite 201A, Houston, Texas 77077
Phone 713/870-8676 Fax 713/870-0161

FIGURE 3 EXAMPLE OF CHAIN OF CUSTODY FORM

REPORT TO:			REMIT TO:		
COMPANY DSM ENVIRONMENTAL SERVICES INC			COMPANY DSM - See Report to		
ADDRESS 1830 S. KIRKWOOD			ADDRESS		
CITY HOUSTON	STATE TX	ZIP 77077	CITY	STATE	ZIP
ATTN PETE DOTSEY	PHONE 713 870 8676	FAX 713 870 0161	ATTN	PHONE	FAX
Client Comments			Project Name		PO #
			Turnaround Time		Release #

ANALYSES REQUESTED

DATE	24HR TIME	MATRIX	COMPOSITE	GRAB	SAMPLE DESCRIPTION	NUMBER CONTAINERS	Chlorides	Conductivity	[illegible]	[illegible] (HNO3)										TERRA SAMPLE NO.
8/8/95	1000	Water		X	Outer < 0.1 Analyze Water Only		X	X	X											PD-4 75827
8/8/95	1140	Water		X			X	X		X										PD-5 75828
8/8/95	1450	Water		X			X	X	X											PD-12 75829
8/8/95	1600	Water		X			X	X	X	X										PD-14 75830
8/9/95	1630	Water		X			X	X	X	X										PD-21 75831
8/9/95	1830	Water		X			X	X	X	X										MW-1 75832

Collected by	Date	Time	Received by Lab	Date	Time	Remarks
Pete Dotsey	8/10/95	0715	Dub Sowy			
Relinquished by	Date	Time	Received by	Date	Time	
Relinquished by Dub Sowy	8/10/95	1630	Received by C. Valdes	VIII.10.95	6:40 PM	

ENVIROLABS INC.
INDUSTRIAL AND ENVIRONMENTAL LABORATORIES

August 30, 1995

DSM Environmental Services Inc.
1830 S. Kirkwood
Suite 201A
Houston TX 77077

REPORT OF ANALYSIS

Sample Identification:	Sample Date	Conductivity (umhos/cm
PD-4/Product Gas/Diesel Envirolabs No. 76-075	8-8-95	*
PD-10/Product Gas/Blend Envirolabs No. 76-076	8-8-95	*
PD-15/Product Gas/Blend Envirolabs No. 76-077	8-9-95	*
PD-26/Product Gas/Blend Envirolabs No. 76-078	8-9-95	*
MIS/Product Gas/Blend Envirolabs No. 76-079	8-9-95	*
PD-27/Product Gas/Blend Envirolabs No. 76-080	8-17-95	*

* Interferences, organic interphase; no ionic activity detected.

Quimico Licenciado
IRIS M. CHEVERE ALONZO
LIC. 2370
Estado Libre Asociado de P.R.

A 378305

CHAIN OF CUSTODY RECORD
ENVIROLABS, INC.

NAME OF CLIENT & POSTAL ADDRESS: DSM ENV. SERV. INC, 1830 S. Kirkwood Suite 2014 Houston TX 77077 — TEL.

SAMPLE COLLECTED BY: Pete Dotsey of DSM

SAMPLE NO.	DATE	TIME	ENVIROLABS NO.	SAMPLE IDENTIFICATION	CONDUCTIVITY				REMARKS
PD-4	8/8/95	1000	76075	Product GAS/DIESEL	X				Resultados para el lunes 8/21/95
PD-10	8/8/95	1420	76076	PRODUCT GAS BLEND	X				
PD-15	8/9/95	1750	76077	PRODUCT GAS BLEND	X				
PD-26	8/9/95	1600	76078	PRODUCT GAS BLEND	X				
MIS-	8/9/95	1725	76079	PRODUCT GAS BLEND	X				MIS AREA TANK 501B
PD-27	8/17/95	1215	76080	PRODUCT GAS BLEND	X				
									Report Results to Pete Dotsey - DSM

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
Pete Dotsey	8/17/95	1420	Carmen N. Ruiz				
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:

RELINQUISHED BY:	DATE	TIME	RECEIVED FOR LAB BY:	DATE	TIME	SAMPLING WITNESSED BY:
Carmen N. Ruiz	8/17/95	2:20pm	Carmen J. López	8/17/95		

ENVIROLABS INC.

INDUSTRIAL AND ENVIRONMENTAL LABORATORIES

SEP 19 1995

August 30, 1995

DSM Environmental Services Inc.
1830 S. Kirkwood
Suite 201A
Houston TX 77077

REPORT OF ANALYSIS

Sample Identification:	Sample Date	Conductivity (umhos/cm
PD-4/Product Gas/Diesel Envirolabs No. 76-075	8-8-95	*
PD-10/Product Gas/Blend Envirolabs No. 76-076	8-8-95	*
PD-15/Product Gas/Blend Envirolabs No. 76-077	8-9-95	*
PD-26/Product Gas/Blend Envirolabs No. 76-078	8-9-95	*
MIS/Product Gas/Blend Envirolabs No. 76-079	8-9-95	*
PD-27/Product Gas/Blend Envirolabs No. 76-080	8-17-95	*

* Interferences, organic interphase; <u>no</u> ionic activity detected.

Quimico Licenciado
IRIS M. CHEVERE ALZORIZO
LIC. 2370
Estado Libre Asociado de P.R.

A 378305

SABANETAS INDUSTRIAL PARK • PONCE, P.R. • TEL. (809) 848-6050
MAILING ADDRESS • P.O. BOX ... • MERCEDITA, PUERTO RICO-00715

CHAIN OF CUSTODY RECORD
ENVIROLABS, INC.

NAME OF CLIENT & POSTAL ADDRESS: DSM ENV. SERV. INC 1830 S. Kirkwood Suite 2014 Houston TX 77077 TEL.

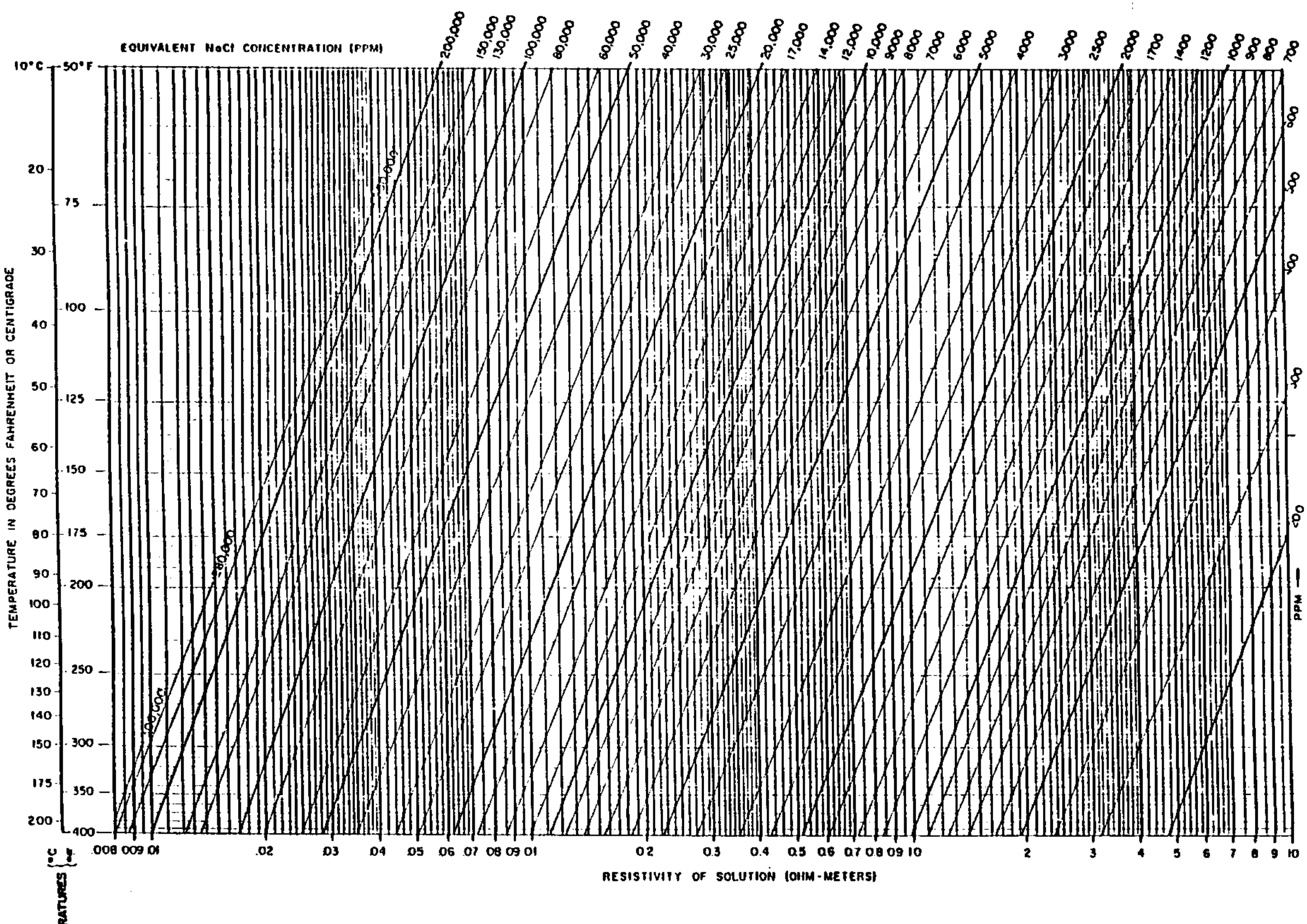
SAMPLE COLLECTED BY: Pete Dotsey of DSM

SAMPLE NO.	DATE	TIME	ENVIROLABS NO.	SAMPLE IDENTIFICATION	CONDUCTIVITY				REMARKS
PD-4	8/8/95	1000	76075	Product GAS/DIESEL	X				Resultados para el lunes
PD-10	8/8/95	1420	76076	PRODUCT GAS BLEND	X				8/21/95
PD-15	8/9/95	1750	76077	PRODUCT GAS BLEND	X				
PD-26	8/9/95	1600	76078	PRODUCT GAS BLEND	X				
MIS-	8/9/95	1725	76079	PRODUCT GAS BLEND	X				MIS AREA TANK 501B
PD-27	8/17/95	1215	76080	PRODUCT GAS BLEND	X				
									Report Results to Pete Dotsey - DSM

RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
Pete Dotsey	8/17/95	1420	Carmen N. Ruiz				
RELINQUISHED BY:	DATE	TIME	RECEIVED BY:	RELINQUISHED BY:	DATE	TIME	RECEIVED BY:
RELINQUISHED BY:	DATE	TIME	RECEIVED FOR LAB BY:	DATE	TIME	SAMPLING WITNESSED BY:	
Carmen N. Ruiz	8/17/95	2:30 pm	Carmen I López	8/17/95			

APPENDIX F-3
RESISTIVITY GRAPH FOR NACL SOLUTIONS AND ARCHIE EQUATION SPREADSHEETS FOR SELECTED WELLS

RESISTIVITY GRAPH FOR NaCl SOLUTIONS



Depth Feet	Conduct mS/m	Resist Ohm-m Rt	Water aturati Sw	NaCl ppm	Water Resitivity Rw @ 75	Porosity est. o	Cementation factor m	Tortuosity factor a	Saturation exponent n
				9084	0.62	0.50	1.30	1.0	1.8
23.6	412.37	2.427	0.77	9084	0.62	0.50	1.30	1	1.8
23.5	412.35	2.427	0.77						
23.4	412.27	2.428	0.77						
23.3	412.09	2.429	0.77						
23.2	411.60	2.431	0.77						
23.1	410.66	2.436	0.77						
23.0	409.41	2.442	0.77						
22.9	408.19	2.450	0.77						
22.8	407.47	2.454	0.77						
22.7	407.29	2.457	0.77						
22.6	407.83	2.453	0.77						
22.5	408.97	2.447	0.77						
22.4	410.64	2.436	0.77						
22.3	412.47	2.424	0.77						
22.2	414.62	2.411	0.78						
22.1	416.97	2.398	0.78						
22.0	419.62	2.382	0.78						
21.9	422.27	2.368	0.78						
21.8	425.11	2.352	0.79						
21.7	428.19	2.337	0.79						
21.6	431.78	2.318	0.79						
21.5	435.70	2.297	0.80						
21.4	440.19	2.272	0.80						
21.3	445.11	2.247	0.81						
21.2	450.61	2.220	0.81						
21.1	456.19	2.193	0.82						
21.0	461.87	2.167	0.82						
20.9	467.26	2.141	0.83						
20.8	472.46	2.118	0.83						
20.7	477.09	2.098	0.84						
20.6	481.35	2.080	0.84						
20.5	485.12	2.063	0.85						
20.4	488.48	2.048	0.85						
20.3	491.50	2.033	0.85						
20.2	494.25	2.021	0.86						
20.1	497.03	2.010	0.86						
20.0	499.78	2.000	0.86		Decreasing Saturation in Potentially				
19.9	502.69	1.990	0.86		Confining Weathered Limestone Unit				
19.8	505.52	1.980	0.87						
19.7	508.29	1.970	0.87						
19.6	510.94	1.960	0.87						
19.5	513.54	1.950	0.87						
19.4	516.22	1.940	0.88						
19.3	518.95	1.929	0.88						
19.2	521.93	1.917	0.88						

19.1	525.21	1.903	0.88	
19.0	528.80	1.890	0.89	
18.9	532.67	1.877	0.89	
18.8	536.78	1.862	0.90	
18.7	541.27	1.847	0.90	
18.6	546.09	1.830	0.90	
18.5	551.09	1.813	0.91	
18.4	555.97	1.798	0.91	
18.3	560.72	1.782	0.92	
18.2	565.36	1.768	0.92	
18.1	569.93	1.753	0.93	
18.0	574.14	1.741	0.93	
17.9	577.98	1.730	0.93	
17.8	581.58	1.720	0.94	
17.7	585.01	1.710	0.94	
17.6	588.19	1.701	0.94	
17.5	590.95	1.693	0.94	
17.4	593.48	1.687	0.95	
17.3	595.83	1.680	0.95	
17.2	598.05	1.673	0.95	
17.1	600.04	1.668	0.95	
17.0	601.78	1.662	0.95	
16.9	603.35	1.658	0.96	
16.8	604.89	1.652	0.96	
16.7	606.70	1.648	0.96	
16.6	608.40	1.643	0.96	
16.5	609.82	1.641	0.96	
16.4	610.48	1.640	0.96	
16.3	610.82	1.640	0.96	
16.2	610.83	1.640	0.96	
16.1	610.64	1.640	0.96	
16.0	610.18	1.640	0.96	
15.9	609.39	1.641	0.96	
15.8	608.53	1.643	0.96	
15.7	607.65	1.647	0.96	
15.6	606.98	1.649	0.96	
15.5	606.51	1.650	0.96	
15.4	606.19	1.650	0.96	
15.3	605.91	1.650	0.96	
15.2	605.40	1.651	0.96	
15.1	604.36	1.654	0.96	Base of Potential Product Bearing Zone
15.0	602.28	1.661	0.95	
14.9	598.92	1.671	0.95	
14.8	594.00	1.684	0.95	
14.7	587.65	1.702	0.94	
14.6	579.80	1.724	0.93	
14.5	570.64	1.752	0.93	
14.4	560.36	1.784	0.92	
14.3	549.32	1.821	0.91	

14.2	537.95	1.860	0.90	
14.1	526.92	1.899	0.89	
14.0	516.75	1.936	0.88	
13.9	508.09	1.968	0.87	
13.8	500.97	1.996	0.86	
13.7	495.18	2.019	0.86	
13.6	490.42	2.039	0.85	
13.5	486.47	2.056	0.85	
13.4	483.25	2.069	0.84	
13.3	480.50	2.080	0.84	
13.2	478.05	2.090	0.84	
13.1	475.83	2.100	0.84	
13.0	473.76	2.110	0.84	
12.9	471.95	2.119	0.83	
12.8	470.52	2.126	0.83	
12.7	469.82	2.128	0.83	Maximum Product Saturation in
12.6	469.89	2.127	0.83	Potential Product Bearing Zone.
12.5	470.96	2.121	0.83	Note Product not observed during drilling.
12.4	472.75	2.113	0.83	
12.3	475.48	2.101	0.84	
12.2	478.87	2.087	0.84	
12.1	482.92	2.070	0.84	
12.0	487.34	2.052	0.85	
11.9	492.16	2.033	0.85	
11.8	497.63	2.011	0.86	
11.7	503.69	1.987	0.86	
11.6	510.64	1.959	0.87	
11.5	518.64	1.929	0.88	
11.4	527.55	1.897	0.89	
11.3	536.87	1.863	0.90	
11.2	546.35	1.830	0.90	
11.1	555.53	1.799	0.91	
11.0	564.82	1.769	0.92	
10.9	573.89	1.741	0.93	
10.8	583.91	1.712	0.94	
10.7	593.99	1.684	0.95	
10.6	604.10	1.657	0.96	
10.5	613.45	1.631	0.96	
10.4	621.26	1.610	0.97	
10.3	627.16	1.596	0.98	
10.2	631.18	1.586	0.98	
10.1	635.18	1.576	0.98	
10.0	639.80	1.563	0.99	
9.9	645.22	1.550	0.99	
9.8	651.15	1.537	1.00	
9.7	658.52	1.520	1.00	Top of Potential Product Bearing Zone
9.6	667.25	1.501	1.01	
9.5	676.56	1.480	1.02	
9.4	684.35	1.463	1.02	

9.3	689.56	1.451	1.03	
9.2	691.82	1.446	1.03	
9.1	691.13	1.446	1.03	Zone of Maximum Water Saturation
9.0	688.85	1.450	1.03	in Weathered Limestone Unit
8.9	686.12	1.457	1.03	
8.8	684.33	1.461	1.02	
8.7	683.04	1.464	1.02	
8.6	681.80	1.467	1.02	
8.5	679.54	1.472	1.02	
8.4	676.55	1.479	1.02	
8.3	672.53	1.488	1.01	
8.2	668.26	1.497	1.01	
8.1	663.27	1.508	1.01	
8.0	658.04	1.520	1.00	
7.9	652.62	1.533	1.00	
7.8	647.05	1.548	0.99	
7.7	641.18	1.562	0.99	
7.6	634.71	1.578	0.98	
7.5	628.08	1.593	0.98	
7.4	621.64	1.610	0.97	Entering zone of aeration in
7.3	615.78	1.626	0.97	Weathered Limestone Unit
7.2	610.34	1.640	0.96	
7.1	605.03	1.653	0.96	
7.0	599.89	1.667	0.95	
6.9	595.17	1.680	0.95	
6.8	590.85	1.693	0.94	
6.7	586.66	1.707	0.94	
6.6	582.53	1.719	0.94	
6.5	578.49	1.730	0.93	
6.4	574.66	1.740	0.93	
6.3	570.96	1.750	0.93	
6.2	567.73	1.760	0.92	
6.1	564.76	1.770	0.92	
6.0	562.22	1.779	0.92	
5.9	559.50	1.788	0.92	
5.8	556.93	1.796	0.91	
5.7	554.53	1.803	0.91	
5.6	552.62	1.809	0.91	
5.5	551.67	1.812	0.91	
5.4	551.59	1.812	0.91	
5.3	552.71	1.809	0.91	
5.2	553.44	1.807	0.91	
5.1	553.08	1.809	0.91	
5.0	550.67	1.818	0.91	
4.9	547.43	1.829	0.90	
4.8	543.70	1.841	0.90	
4.7	540.20	1.853	0.90	
4.6	536.38	1.867	0.89	
4.5	532.25	1.881	0.89	

4.4	527.98	1.896	0.89						
4.3	524.38	1.908	0.88						
4.2	522.41	1.914	0.88						
4.1	521.63	1.917	0.88						
4.0	521.56	1.917	0.88						

Depth Feet	Conduct mS/m	Resist Ohm-m Rt	Water Saturation Sw	NaCl ppm	Water Resitivity Rw @ 75	Porosity est. o	Cementation factor m	Tortuosity factor a	Saturation exponent n
61.0	133.088	7.514	1.00	2607	2.1	0.40	1.40	1.00	1.8
60.9	131.658	7.598	1.00						
60.8	129.557	7.722	0.99		Base of product bearing zone				
60.7	127.396	7.852	0.98		Estimated Oil/Water Contact				
60.6	125.741	7.954	0.97						
60.5	124.983	8.002	0.97						
60.4	124.763	8.017	0.97						
60.3	123.878	8.077	0.96						
60.2	121.469	8.249	0.95						
60.1	117.318	8.548	0.94						
60.0	113.197	8.853	0.92						
59.9	110.163	9.083	0.90						
59.8	108.001	9.264	0.89						
59.7	105.534	9.486	0.88						
59.6	102.487	9.769	0.87						
59.5	99.487	10.061	0.85						
59.4	97.139	10.301	0.84						
59.3	95.446	10.482	0.83						
59.2	94.382	10.599	0.83						
59.1	93.536	10.694	0.83						
59.0	92.833	10.774	0.82						
58.9	92.213	10.844	0.82						
58.8	91.846	10.886	0.82						
58.7	91.573	10.917	0.82						
58.6	91.232	10.958	0.81						
58.5	90.606	11.034	0.81						
58.4	89.967	11.113	0.81						
58.3	89.437	11.179	0.81						
58.2	89.451	11.178	0.81						
58.1	89.709	11.147	0.81						
58.0	89.916	11.122	0.81						
57.9	89.788	11.138	0.81						
57.8	89.553	11.167	0.81						
57.7	89.491	11.173	0.81						
57.6	89.510	11.171	0.81						
57.5	89.383	11.187	0.81						
57.4	89.264	11.202	0.80		Maximum Oil Saturation				
57.3	89.430	11.183	0.81						
57.2	90.230	11.088	0.81						
57.1	91.349	10.953	0.81						
57.0	92.620	10.802	0.82						
56.9	93.599	10.688	0.83						
56.8	94.638	10.570	0.83						
56.7	95.634	10.460	0.84						
56.6	96.757	10.338	0.84						
56.5	97.950	10.212	0.85						

56.4	99.347	10.070	0.85					
56.3	101.107	9.896	0.86					
56.2	102.937	9.719	0.87					
56.1	104.842	9.541	0.88					
56.0	106.508	9.390	0.89					
55.9	108.146	9.247	0.90					
55.8	109.716	9.114	0.90					
55.7	111.833	8.944	0.91					
55.6	114.174	8.762	0.92					
55.5	116.924	8.556	0.93					
55.4	119.492	8.372	0.95					
55.3	121.924	8.204	0.96					
55.2	124.103	8.062	0.97					
55.1	126.226	7.928	0.97					
55.0	128.830	7.769	0.99		Top of Oil Bearing Zone			
54.9	131.343	7.618	1.00					
54.8	133.753	7.478	1.01					
54.7	135.667	7.372	1.02					
54.6	137.760	7.261	1.02					
54.5	140.289	7.131	1.03					
54.4	143.063	6.992	1.05		Base Perched Water Zone			
54.3	145.454	6.874	1.06		Indicated by Conductivity Trace			
54.2	146.757	6.811	1.06					
54.1	147.101	6.794	1.06					
54.0	147.083	6.796	1.06					

Depth Feet	Conduct mS/m	Resist Ohm-m Rt	Water turati Sw	NaCl ppm	Water Resitivity Rw @ 75	Porosity est. o	Cementation factor m	Tortuosity factor a	Saturation exponent n
42.4	90.216	13.487	1.00	2181	2.6	0.4	1.8	1	1.8
42.3	90.263	13.482	1.00						
42.2	90.361	13.470	1.00						
42.1	90.369	13.470	1.00						
42.0	90.264	13.484	1.00						
41.9	90.182	13.495	1.00						
41.8	90.348	13.473	1.00						
41.7	90.442	13.461	1.00						
41.6	90.100	13.508	1.00						
41.5	89.209	13.629	1.00						
41.4	88.389	13.742	0.99		Base of product bearing zone				
41.3	87.570	13.858	0.99						
41.2	86.646	13.995	0.98						
41.1	85.293	14.193	0.97						
41.0	84.054	14.378	0.97						
40.9	83.244	14.499	0.96						
40.8	82.817	14.567	0.96						
40.7	82.756	14.578	0.96						
40.6	82.846	14.564	0.96						
40.5	83.351	14.486	0.96						
40.4	83.876	14.406	0.97						
40.3	84.686	14.282	0.97						
40.2	85.303	14.190	0.97						
40.1	85.731	14.125	0.98						
40.0	85.386	14.175	0.97						
39.9	84.671	14.281	0.97						
39.8	83.952	14.390	0.97						
39.7	83.448	14.468	0.96						
39.6	82.822	14.569	0.96						
39.5	82.149	14.678	0.96						
39.4	81.763	14.740	0.95						
39.3	81.979	14.704	0.95						
39.2	82.290	14.652	0.96						
39.1	82.351	14.640	0.96						
39.0	82.199	14.665	0.96						
38.9	81.907	14.711	0.95						
38.8	81.758	14.735	0.95						
38.7	81.348	14.802	0.95						
38.6	80.969	14.866	0.95						
38.5	80.518	14.941	0.95		Zone of Maximum Product Saturation				
38.4	80.477	14.949	0.95						
38.3	80.583	14.931	0.95						
38.2	80.834	14.889	0.95						
38.1	81.114	14.842	0.95						
38.0	81.462	14.785	0.95						
37.9	81.994	14.698	0.96						
37.8	82.450	14.626	0.96						
37.7	83.079	14.526	0.96						

37.6	83.484	14.462	0.96	
37.5	83.829	14.408	0.97	
37.4	84.219	14.351	0.97	
37.3	85.084	14.223	0.97	
37.2	86.340	14.037	0.98	
37.1	87.512	13.865	0.99	
37.0	88.309	13.750	0.99	Top of product bearing zone
36.9	88.931	13.664	0.99	
36.8	89.901	13.536	1.00	
36.7	91.137	13.374	1.01	
36.6	92.584	13.186	1.01	
36.5	93.559	13.059	1.02	
36.4	94.294	12.965	1.02	
36.3	94.909	12.892	1.03	
36.2	95.644	12.804	1.03	
36.1	96.600	12.691	1.04	
36.0	97.184	12.623	1.04	
35.9	97.576	12.578	1.04	
35.8	97.417	12.597	1.04	
35.7	97.243	12.618	1.04	
35.6	96.929	12.654	1.04	
35.5	96.577	12.696	1.04	
35.4	96.004	12.763	1.03	
35.3	95.283	12.849	1.03	
35.2	94.583	12.935	1.03	
35.1	93.997	13.006	1.02	
35.0	93.594	13.055	1.02	
34.9	93.307	13.090	1.02	
34.8	93.109	13.115	1.02	
34.7	93.018	13.127	1.02	
34.6	93.217	13.102	1.02	
34.5	93.703	13.040	1.02	
34.4	94.484	12.943	1.02	
34.3	95.398	12.834	1.03	
34.2	96.537	12.700	1.04	
34.1	97.998	12.532	1.04	Base of overlying perched water zone
34.0	100.026	12.307	1.05	
33.9	102.586	12.035	1.07	
33.8	105.639	11.726	1.08	
33.7	108.976	11.407	1.10	
33.6	112.669	11.075	1.12	
33.5	116.592	10.743	1.14	
33.4	120.808	10.407	1.16	
33.3	125.261	10.077	1.18	
33.2	129.958	9.751	1.20	
33.1	134.573	9.450	1.22	
33.0	139.186	9.171	1.24	
32.9	143.659	8.914	1.26	
32.8	148.131	8.671	1.28	
32.7	152.308	8.455	1.30	
32.6	156.088	8.269	1.31	

32.5	159.587	8.106	1.33						
32.4	162.552	7.973	1.34		Perched Water Zone				
32.3	165.187	7.858	1.35						
32.2	167.286	7.768	1.36						
32.1	169.370	7.682	1.37						
32.0	171.311	7.604	1.38						

Depth	Conduct	Resist	Water	NaCl	Water	Porosity	ementatio	Tortuosity	Saturation
Feet	mS/m	Ohm-m	Saturation	ppm	Resitivity	est.	factor	factor	exponent
		Rt	Sw		Rw @ 75	o	m	a	n
35.4	79.540	12.576	0.99	1489	3.4	0.40	1.40	1.00	1.8
35.3	79.296	12.620	0.98		Base of oil bearing zone estimated at 35.5 feet bgs				
35.2	78.527	12.747	0.98						
35.1	77.444	12.923	0.97						
35.0	76.350	13.108	0.96						
34.9	75.103	13.333	0.95						
34.8	73.476	13.630	0.94						
34.7	71.904	13.921	0.93						
34.6	70.692	14.153	0.92						
34.5	69.346	14.432	0.91						
34.4	68.783	14.553	0.91		Maximum product saturation zone				
34.3	69.510	14.423	0.91						
34.2	72.266	13.889	0.93						
34.1	75.366	13.308	0.96						
34.0	77.970	12.836	0.97						
33.9	79.738	12.544	0.99						
33.8	80.121	12.489	0.99						
33.7	80.207	12.483	0.99						
33.6	79.210	12.648	0.98						
33.5	79.628	12.580	0.99		Top of product bearing zone				
33.4	79.794	12.550	0.99						
33.3	81.533	12.278	1.00						
33.2	83.147	12.044	1.01						
33.1	85.924	11.654	1.03						
33.0	88.718	11.290	1.05						
32.9	91.649	10.923	1.07						
32.8	93.891	10.657	1.08		Base of overlying perched water zone				
32.7	95.964	10.428	1.09						
32.6	97.578	10.257	1.10						
32.5	99.878	10.022	1.12						
32.4	101.933	9.820	1.13						
32.3	104.449	9.580	1.15						
32.2	106.416	9.402	1.16						
32.1	108.579	9.213	1.17						
32.0	111.094	9.009	1.19						

Depth Feet	Conduct mS/m	Resist Ohm-m Rt	Water Saturation Sw	NaCl ppm	Water Resitivity Rw @ 75	Porosity est. o	Cementation factor m	Tortuosity factor a	Saturation exponent n
124.6	261.577	3.821	0.97	5800	1.0	0.40	1.40	1.00	1.8
124.5	262.288	3.811	0.97						
124.4	263.178	3.799	0.97						
124.3	263.822	3.791	0.97		Base of product bearing zone				
124.2	264.003	3.789	0.97						
124.1	263.481	3.797	0.97						
124.0	262.036	3.817	0.97						
123.9	259.971	3.847	0.96						
123.8	257.747	3.879	0.96						
123.7	255.710	3.909	0.96						
123.6	253.709	3.939	0.95						
123.5	251.794	3.969	0.95						
123.4	249.748	4.002	0.94						
123.3	247.831	4.034	0.94						
123.2	246.049	4.064	0.94						
123.1	244.801	4.086	0.93						
123.0	243.914	4.100	0.93						
122.9	243.273	4.110	0.93						
122.8	242.748	4.119	0.93						
122.7	242.583	4.122	0.93						
122.6	242.851	4.119	0.93						
122.5	243.396	4.110	0.93						
122.4	244.016	4.100	0.93						
122.3	244.548	4.091	0.93						
122.2	245.080	4.082	0.93						
122.1	245.434	4.076	0.93						
122.0	245.583	4.072	0.93						
121.9	245.261	4.077	0.93						
121.8	244.641	4.087	0.93						
121.7	243.982	4.098	0.93						
121.6	243.463	4.107	0.93						
121.5	243.108	4.112	0.93						
121.4	242.626	4.120	0.93						
121.3	242.098	4.129	0.93						
121.2	241.511	4.140	0.93						
121.1	241.194	4.146	0.93						
121.0	241.067	4.148	0.93						
120.9	241.044	4.147	0.93						
120.8	240.882	4.149	0.93						
120.7	240.650	4.153	0.92						
120.6	240.174	4.163	0.92						
120.5	239.537	4.176	0.92						
120.4	238.651	4.191	0.92						
120.3	237.763	4.207	0.92						
120.2	236.748	4.226	0.92						
120.1	235.527	4.248	0.91						

120.0	234.209	4.271	0.91	Zone of maximum product saturation
119.9	233.076	4.291	0.91	appears to be slightly above top of fluid level
119.8	232.438	4.303	0.91	screen set low and log depth may be slightly off.
119.7	232.289	4.307	0.91	
119.6	232.478	4.303	0.91	
119.5	232.943	4.293	0.91	
119.4	233.744	4.278	0.91	
119.3	235.089	4.252	0.91	
119.2	237.000	4.219	0.92	
119.1	239.346	4.179	0.92	
119.0	241.848	4.138	0.93	
118.9	244.479	4.094	0.93	
118.8	247.097	4.051	0.94	
118.7	249.984	4.003	0.94	
118.6	252.972	3.954	0.95	
118.5	256.254	3.903	0.96	
118.4	259.467	3.856	0.96	
118.3	262.772	3.808	0.97	Top product zone
118.2	265.969	3.762	0.98	
118.1	269.121	3.718	0.98	
118.0	272.103	3.678	0.99	
117.9	274.841	3.641	0.99	
117.8	277.421	3.607	1.00	
117.7	279.448	3.579	1.00	
117.6	281.329	3.554	1.01	Increased water saturation just above
117.5	282.976	3.534	1.01	top of saturated zone
117.4	284.798	3.513	1.01	
117.3	286.422	3.494	1.02	
117.2	287.709	3.479	1.02	
117.1	288.640	3.467	1.02	
117.0	289.217	3.459	1.02	
116.9	289.550	3.454	1.02	
116.8	289.608	3.454	1.02	
116.7	289.349	3.458	1.02	
116.6	288.872	3.463	1.02	
116.5	288.116	3.471	1.02	
116.4	287.167	3.481	1.02	
116.3	285.901	3.496	1.02	
116.2	284.351	3.514	1.01	
116.1	282.541	3.538	1.01	
116.0	280.686	3.562	1.01	
115.9	278.813	3.587	1.00	
115.8	277.061	3.610	1.00	
115.7	275.407	3.632	1.00	
115.6	274.154	3.650	0.99	
115.5	273.408	3.660	0.99	
115.4	273.244	3.661	0.99	
115.3	273.449	3.657	0.99	
115.2	273.917	3.649	0.99	

115.1	274.689	3.639	1.00						
115.0	275.604	3.628	1.00						
114.9	276.836	3.613	1.00						
114.8	278.070	3.598	1.00						
114.7	279.708	3.577	1.00						
114.6	281.533	3.553	1.01						
114.5	283.776	3.526	1.01						
114.4	286.276	3.494	1.02						
114.3	289.042	3.461	1.02						
114.2	291.928	3.427	1.03						
114.1	294.716	3.396	1.03						
114.0	297.336	3.366	1.04						
113.9	299.880	3.337	1.04						
113.8	302.387	3.308	1.05						
113.7	304.848	3.281	1.05						
113.6	307.240	3.257	1.06						
113.5	309.642	3.232	1.06						
113.4	312.120	3.207	1.07						
113.3	314.669	3.180	1.07						
113.2	317.308	3.153	1.08						
113.1	319.862	3.128	1.08						
113.0	322.392	3.102	1.09						
112.9	324.831	3.078	1.09						
112.8	327.372	3.053	1.10						
112.7	329.777	3.032	1.10						
112.6	331.988	3.013	1.11						
112.5	333.837	2.998	1.11						
112.4	335.304	2.984	1.11						
112.3	336.284	2.976	1.11						
112.2	336.829	2.970	1.11						
112.1	337.023	2.968	1.11						
112.0	336.769	2.969	1.11						
111.9	335.863	2.977	1.11						
111.8	334.420	2.990	1.11						
111.7	332.666	3.007	1.11						
111.6	330.958	3.022	1.10						
111.5	329.349	3.036	1.10						
111.4	327.997	3.047	1.10						
111.3	326.797	3.058	1.10						
111.2	325.697	3.070	1.09						
111.1	324.811	3.080	1.09						
111.0	324.347	3.084	1.09						
110.9	324.264	3.083	1.09						
110.8	324.231	3.082	1.09						
110.7	324.228	3.082	1.09						
110.6	324.264	3.083	1.09						
110.5	324.566	3.082	1.09						
110.4	324.773	3.081	1.09						
110.3	324.832	3.081	1.09						

110.2	324.654	3.082	1.09	
110.1	324.281	3.086	1.09	
110.0	323.872	3.089	1.09	
109.9	323.319	3.094	1.09	
109.8	322.861	3.099	1.09	
109.7	322.382	3.103	1.09	
109.6	322.016	3.107	1.09	
109.5	321.698	3.109	1.09	
109.4	321.571	3.109	1.09	
109.3	321.597	3.108	1.09	
109.2	321.842	3.106	1.09	
109.1	321.992	3.106	1.09	
109.0	321.936	3.107	1.09	
108.9	321.418	3.112	1.09	
108.8	320.512	3.121	1.08	
108.7	319.161	3.134	1.08	
108.6	317.381	3.152	1.08	
108.5	315.141	3.174	1.07	
108.4	312.634	3.200	1.07	
108.3	309.733	3.229	1.06	
108.2	306.520	3.262	1.06	
108.1	302.890	3.301	1.05	
108.0	299.238	3.342	1.04	
107.9	295.704	3.382	1.04	
107.8	292.389	3.420	1.03	
107.7	289.380	3.454	1.02	
107.6	286.780	3.484	1.02	
107.5	284.764	3.509	1.02	
107.4	283.287	3.528	1.01	
107.3	282.427	3.540	1.01	
107.2	282.159	3.544	1.01	
107.1	282.448	3.541	1.01	
107.0	283.104	3.533	1.01	
106.9	284.099	3.521	1.01	
106.8	285.362	3.507	1.02	
106.7	286.901	3.488	1.02	
106.6	288.674	3.466	1.02	
106.5	290.663	3.440	1.03	
106.4	292.869	3.413	1.03	
106.3	295.159	3.387	1.04	
106.2	297.667	3.359	1.04	
106.1	300.247	3.330	1.05	
106.0	303.104	3.299	1.05	Base of perched water zone
105.9	306.008	3.267	1.06	
105.8	309.130	3.233	1.06	
105.7	312.221	3.201	1.07	
105.6	315.439	3.169	1.07	
105.5	318.779	3.137	1.08	
105.4	322.342	3.102	1.09	

Depth Feet	Conduct mS/m	Resist Ohm-m Rt	Water Saturation Sw	NaCl ppm	Water Resitivity Rw @ 75	Porosity est. o	ementatio factor m	Tortuosity factor a	Saturation exponent n
137.9	260.100	3.840	1.02	5001	1.10	0.40	1.40	1.00	1.8
137.8	260.340	3.840	1.02						
137.7	259.830	3.850	1.02						
137.6	259.670	3.850	1.02						
137.5	259.300	3.860	1.02						
137.4	261.010	3.830	1.02						
137.3	260.980	3.830	1.02						
137.2	262.280	3.810	1.02						
137.1	262.950	3.800	1.02						
137.0	263.360	3.800	1.02						
136.9	264.240	3.780	1.03						
136.8	263.160	3.800	1.02						
136.7	262.950	3.800	1.02						
136.6	263.380	3.800	1.02						
136.5	263.260	3.800	1.02						
136.4	263.600	3.790	1.03						
136.3	264.920	3.770	1.03						
136.2	265.170	3.770	1.03						
136.1	264.740	3.780	1.03						
136.0	263.590	3.790	1.03						
135.9	260.760	3.830	1.02						
135.8	258.380	3.870	1.01						
135.7	254.460	3.930	1.01						
135.6	249.890	4.000	1.00						
135.5	244.930	4.080	0.98		Base of product bearing zone.				
135.4	238.270	4.200	0.97						
135.3	231.600	4.320	0.95						
135.2	226.120	4.420	0.94						
135.1	221.140	4.520	0.93						
135.0	217.620	4.600	0.92						
134.9	214.460	4.660	0.91						
134.8	211.800	4.720	0.91						
134.7	209.390	4.780	0.90						
134.6	207.820	4.810	0.90						
134.5	206.770	4.840	0.90						
134.4	205.470	4.870	0.89						
134.3	203.960	4.900	0.89						
134.2	203.090	4.920	0.89						
134.1	203.490	4.910	0.89						
134.0	202.870	4.930	0.89						
133.9	203.490	4.910	0.89						
133.8	202.600	4.940	0.89						
133.7	203.480	4.910	0.89						
133.6	203.980	4.900	0.89						
133.5	203.510	4.910	0.89						
133.4	204.550	4.890	0.89						

133.3	204.570	4.890	0.89						
133.2	204.800	4.880	0.89						
133.1	204.550	4.890	0.89						
133.0	205.150	4.870	0.89						
132.9	205.050	4.880	0.89						
132.8	204.160	4.900	0.89						
132.7	204.150	4.900	0.89						
132.6	203.230	4.920	0.89						
132.5	202.510	4.940	0.89						
132.4	202.190	4.950	0.88						
132.3	202.200	4.950	0.88						
132.2	202.450	4.940	0.89						
132.1	202.200	4.950	0.88						
132.0	202.200	4.950	0.88						
131.9	202.500	4.940	0.89						
131.8	202.590	4.940	0.89						
131.7	201.550	4.960	0.88						
131.6	201.120	4.970	0.88						
131.5	199.590	5.010	0.88		Top of saturated/product bearing zone				
131.4	198.680	5.030	0.88						
131.3	196.320	5.090	0.87						
131.2	195.670	5.110	0.87						
131.1	194.100	5.150	0.87						
131.0	193.680	5.160	0.86						